

Institute of Dentistry, Faculty of Medicine,
University of Helsinki, Finland

**Oral Health in a Non-institutionalized
Disabled School Population**

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Academic dissertation

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Contents

LIST OF ORIGINAL PUBLICATIONS.....	6
1. INTRODUCTION.....	7
2. REVIEW OF LITERATURE.....	11
Definitions of disability.....	11
Types of disability.....	13
Prevalence of disability.....	15
Effects of disability.....	17
Barriers to oral health.....	19
Oral health status among the disabled.....	20
Dental caries experience among the disabled.....	20
Oral hygiene and periodontal conditions among the disabled.....	23
Malocclusions among the disabled.....	25
Traumatic injuries among the disabled.....	26
Dental fluorosis among the disabled.....	27
Oral hygiene interventions among the disabled.....	28
3. AIMS OF THE STUDY.....	34
4. SUBJECTS AND METHODS.....	35
Study population.....	35
Clinical data.....	37
<i>Dental status.....</i>	<i>39</i>
<i>Dental caries.....</i>	<i>39</i>
<i>Oral hygiene status.....</i>	<i>40</i>
<i>Oral hygiene habits.....</i>	<i>40</i>
<i>Periodontal condition and treatment needs.....</i>	<i>40</i>
<i>Malocclusions.....</i>	<i>42</i>
<i>Traumatic injuries.....</i>	<i>42</i>
<i>Dental fluorosis.....</i>	<i>42</i>
<i>Plaque and gingival scoring.....</i>	<i>43</i>

Statistical methods.....	44
<i>Examiner reliability.....</i>	<i>45</i>
5. RESULTS.....	46
Dental caries experience (I).....	46
<i>Dental caries in the primary dentition.....</i>	<i>46</i>
<i>Dental caries in the permanent dentition.....</i>	<i>48</i>
Oral hygiene and periodontal conditions (II).....	53
<i>Oral hygiene habits.....</i>	<i>53</i>
<i>Oral hygiene status.....</i>	<i>54</i>
<i>Periodontal status.....</i>	<i>55</i>
<i>Periodontal treatment needs.....</i>	<i>55</i>
Malocclusions and traumatic injuries (III).....	58
<i>Malocclusions.....</i>	<i>58</i>
<i>Traumatic injuries.....</i>	<i>58</i>
Dental fluorosis (IV).....	59
Incidence of dental caries (V).....	59
Supervised toothbrushing programme (VI).....	60
6. DISCUSSION.....	63
Methodological aspects.....	63
<i>Study design.....</i>	<i>63</i>
Clinical data.....	63
<i>DMF index.....</i>	<i>63</i>
<i>James index.....</i>	<i>64</i>
<i>CPITN index.....</i>	<i>64</i>
<i>Dean's index.....</i>	<i>67</i>
<i>Silness and Loe plaque index and Loe and Silness gingival index.....</i>	<i>67</i>
Results.....	68
<i>Oral health status.....</i>	<i>68</i>
<i>Dental caries experience.....</i>	<i>69</i>
<i>Caries incidence and increment.....</i>	<i>77</i>

<i>Oral hygiene and periodontal conditions.....</i>	78
<i>Malocclusions.....</i>	82
<i>Traumatic injuries.....</i>	84
<i>Dental fluorosis.....</i>	86
Toothbrushing intervention programme among subjects with Down syndrome.....	88
Suggested strategies for improvement of oral health.....	91
<i>Preventive measures.....</i>	91
<i>Oral health education.....</i>	94
<i>School oral health services.....</i>	95
Conclusions.....	97
Recommendations.....	98
7. SUMMARY.....	100
8. ACKNOWLEDGEMENTS.....	103
REFERENCES.....	105
APPENDICES 1-5.....	128
ORIGINAL PUBLICATIONS.....	

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original publications, which will be referred to in the text by their Roman numerals:

- I Shyama M, Al-Mutawa SA, Morris RE, Sugathan T, Honkala E. Dental caries experience of disabled children and young adults in Kuwait. *Community Dent Health* 2001; 18: 181-186.
- II Shyama M, Al-Mutawa SA, Honkala S, Sugathan T, Honkala E. Oral hygiene and periodontal conditions in special needs children and young adults in Kuwait. *J Disabil Oral Health* 2000; 1: 13-19.
- III Shyama M, Al-Mutawa SA, Honkala S. Malocclusions and traumatic injuries in disabled schoolchildren and adolescents in Kuwait. *Spec Care Dent* 2001; 21: 104-108.
- IV Shyama M, Al-Mutawa SA, Honkala S. Prevalence of dental fluorosis in disabled children and young adults in Kuwait. *Med Principles Pract* 2001; 10: 93-97.
- V Al-Mutawa SA, Shyama M, Honkala S, Honkala E. Incidence of dental caries in children and young adults with Down syndrome in Kuwait. *J Disabil Oral Health* 2003; 4: 58-63.
- VI Shyama M, Al-Mutawa SA, Honkala S, Honkala E. Supervised toothbrushing and oral health education program in Kuwait for children and young adults with Down syndrome. *Spec Care Dent* 2003; 23: 94-99.

1. INTRODUCTION

The disabled form a substantial section of the community, and it is estimated that worldwide there are about 500 million people with disabilities (Watson, 2000). Enhanced survival, more sophisticated medical care and increased longevity increase the numbers of disabled individuals (Watson, 2000). The greatest challenge that people with disabilities have had to face has been society's misperception that they are a "breed apart", as historically they have been pitied, ignored, vilified or even hidden away in institutions. Providing health care services for children with special health care needs will continue to be a challenge in the 21st century (Giardino & Arye, 2000).

Until the second half of the 20th century, it was rare for the society to recognize that, apart from the specific impairment, people with disabilities have the same abilities, needs and interests as the rest of the population. Nevertheless, discrimination continued to exist in certain important areas like educational opportunities, health care services, etc. In recent decades, this situation has undergone some positive changes through adjustments in legislation and public attitudes. In addition, people with disabilities have lobbied for their rights as full citizens and productive individuals.

The United Nations Expert Group for persons with disabilities defined its policy for the year 2000 and beyond in the following words: "Towards a Society for All - from Awareness to Action" (United Nations Expert Group Meeting, 1992). The policy implied by this heading means normalization and integration, equality and full participation, de-institutionalization and community-based rehabilitation. Persons with disabilities are active purpose-oriented individuals with the desire and right to be in charge of their lives, masters of their own destiny; highly specialized services are sometimes needed, but separate services should be avoided (Haavio, 1995).

In the first-ever Surgeon General's Report, Oral Health in America (U.S. Department of Health and Human Services, 2000a) and the recent release of Healthy People 2010 (U.S. Department of Health and Human Services, 2000b) many aspects of the oral health care for individuals with special needs were highlighted. Oral health and quality oral health care contribute to holistic health, which should be a right rather than a privilege (Clark & Vanek, 1984). That is why individuals with disabilities deserve the same opportunities for dental services as those who are healthy. The Disability Discrimination Act (1999) covers health services and makes it unlawful to treat a person who is disabled less favourably for a reason related to their

disability, and service providers are required to make reasonable attempts to accommodate those people with disabilities. Although individuals who are disabled are entitled to the same standards of health and care as the general population, there is evidence that they experience poorer general and oral health, have unmet health needs and lower uptake of screening services (British Society for Disability and Oral Health, 2000; 2001). However, where preventive and treatment services are targeted at particular groups, the evidence is that oral health can be maintained at a high level (Nunn, 2003). Despite the specialized knowledge available in the modern era and the approaches used by dental practitioners to enable treatment under normal conditions, it still remains impossible to treat certain patients conventionally (Hennequin et al., 2000) and dental care is often generated as an emergency (Persson et al., 2000). As a consequence of their impairment, particular behaviour management techniques involving safe and effective positioning may extend to the use of conscious sedation or even general anaesthesia as an adjunct to care (Klingberg et al., 2000). Unfortunately, the main content of treatment planning is, even today, extraction of decayed teeth (Dicks, 1995). To carry out dental care for the severely and profoundly disabled since general anaesthesia is necessary and since a general anaesthetic should be administered as infrequently as possible in a patient's lifetime, when there has been any doubt about treatment, the clinical decision has been to extract carious teeth (Costello, 1990). The oral health of the disabled may be neglected because of the disability condition, a demanding disease or limited access to oral health care. Moreover, because of their level of function and their limited ability to undergo an oral examination, the disabled present specific challenges when their oral health is assessed (Tesini, 1981). However, with appropriate planning, clear communication and carefully drawn limits to the service provided, the dramatic dental neglect experienced by the majority of these individuals can be successfully alleviated (Haavio, 1995).

In spite of the high level of dental disease, individuals with disabilities or illnesses receive less oral care than the normal population. Characteristically, it has been reported, "dental treatment is the greatest unattended health need of the disabled" (Hennequin, 2000). Some of the most important reasons may be inadequate recall systems, practical difficulties during treatment sessions, socioeconomic status and underestimation of treatment needs or pain, communication problems and bad cooperation (Boj & Davila, 1995; Brandes et al., 1995; Dicks, 1995; Glassman et al., 1996; Hennequin et al., 2000). Dental health status and disability are both related to the patient's social acceptability. It is important for children who are disabled to have proper dental care (Waldman, 1999a). Although there are many epidemiological studies

concerning individuals with some kind of disability or illness, there is a paucity of information about the planning, implementation and evaluation of dental programmes for these patients (Haavio, 1995).

Nowak (1984) was the first to report in the United States on how the normalization process affects the oral condition of persons with disabilities. Coordination of care and understanding of special care issues in oral health are essential for all members of a patient's health care team, including medical and dental professionals and caregivers. Dental care of the disabled ought to be a normal part of the responsibilities of the pedodontist, and it will be one of the most challenging tasks of the profession to care for this underprivileged part of our population. From a policy and planning perspective, in industrialised countries it has been commonly accepted that the disadvantaged in society should receive similar or even more intensive care than the general population and that their special health care needs must be targetted (The Berlin Declaration, 1995).

The World Health Organization (WHO) defined Health as "a state of complete physical, mental, and social well-being, rather than solely the absence of disease" (WHO, 2000). Oral health has been defined as "the standard of health of the oral and related tissues which enables an individual to eat, speak and socialise without active disease, discomfort and embarrassment and which contributes to general well-being". Oral health has strong biological, psychological and social projections, because it affects our aesthetics and communication, and the quality of life is affiliated with oral health status (Gabre et al., 1999). Good oral health is also important for proper mastication, digestion, appearance, speech and health. Oral health is linked to happiness and good general health and there is evidence that aesthetically acceptable and functionally adequate dentitions affect self-esteem, confidence and socialisation (Fiske et al., 1998). The impact of oral conditions on quality of life can be profound (Locker, 1992). At present, dental disease is the most prevalent problem in the Western world (Waldman, 1991).

In Kuwait, the population is currently 2.36 million (2002), of which 31.4% are under 20 years old (Public Authority for Civil Information, 2002). There is a national system of health care; and all children have access to oral health care located in clinics, polyclinics, specialist centres, and hospitals, as well as in an expanding private sector. In addition, the Kuwaiti Ministry of Health has implemented a school-based, systematic programme of oral health care for kindergartens and the primary grades of schoolchildren. Specific dental preventive projects targeted to children were initiated in the mid -1980's and were expanded after the war, in 1991.

All 5-health regions of Kuwait now have children's oral health programmes, and 95% of the targeted Kuwaiti children are enrolled. The school oral health programmes are called the National School Oral Health Programme. Prior to 2002, however, schools for those with disabilities were not included in this school health scheme.

According to government records, Kuwait has about 900 non-institutionalized individuals with sensory, physical and developmental disabilities attending special-needs schools. Since 2002, the services have been expanded to cater to the needs of these schoolchildren with special needs. No national data exist for disabled children who do not attend these schools.

Kuwait is one of the few Arabic countries where national oral health surveys have been conducted. The first national oral health survey of 5- to 16-year-olds was carried out in 1982 (Glass, 1983); a post-war national oral health survey of 4-, 6-, 12-, and 15-year-olds was completed in 1993 (Skougaard & Vigild, 1993; Vigild et al., 1996), and an oral health survey of 5- to 14-years-olds was conducted in 2000 (Soparkar et al., 2001; Al-Mutawa et al., 2002).

While disabled children are recognised as being in the category of high risk for dental disease, in Kuwait dental services have not previously been delivered to them as a priority group. As a result of growing concern in Kuwait about the oral health of subjects with disabilities this epidemiological dental study was instituted to investigate the oral health status and dental needs of this population. The study was designed to identify base-line needs that would prompt improvements in the oral health status of this high-risk population.

2. REVIEW OF LITERATURE

Definitions of disability

The WHO defines a handicapped individual as one who, over an appreciable time, is prevented by a physical or mental condition from full participation in the normal activities of his age group, including social, recreational, educational and vocational activities (WHO, 1980a). The American Public Health Association defines a handicapped child as “A child who cannot within limits play, learn, work, or do things other children of his age can do; he is hindered in achieving his full physical, mental, and social potentialities” (Troutman, 1970). Children with chronic diseases or with congenital or acquired conditions interfering with normal physical and/or mental development are often defined as disabled or handicapped (Storhaug et al., 1997).

It is also necessary to distinguish between the term disability and handicap. Handicap is the loss or limitation of opportunities to take part in the normal life of the community on an equal level with others due to physical and social barriers (Waldman, 1995). The term disability has recently been defined as any impairment that restricts or limits daily activity in some manner. Disability is the functional limitation within the individual, caused by physical, mental, or sensory impairments and can be developmental in origin or acquired (Tesini & Fenton, 1994). Individuals with disabilities, according to the definition given by the WHO (1980a), have a disadvantaged condition that arises from a deficiency or disability, which restricts their fulfilment of a role, that is normal or within the normal limit of a human being. According to the International Classification of Impairments, Disabilities, and Handicaps (ICIDH), impairment is defined as any loss or abnormality of psychological, physiological or anatomical structure or function, disability as any restriction or lack (resulting from an impairment) of ability to perform an activity in a manner or within the range considered normal for a person, and handicap as the disadvantage for a given individual, resulting from an impairment or a disability which limits or prevents the fulfillment of a role that is normal for that individual (WHO, 1980a). Disability represents a departure from the norm in terms of individual performance, while handicap is a social phenomenon, representing the social and environmental consequences for the individual stemming from the presence of impairment and disability (WHO, 1980a).

The medical model attempts to link the experience of disabled people with that of the professionals treating them (Nunn, 2000). There has been a gradual move away from the

medical model - to the social model where the emphasis is more on the environment imposing disability on a person with impairment (Hutchison, 1995). The revised draft of the ICIDH seeks to move away from this medical model to a bio-psycho-social model in order to encompass human function at the bodily, personal and social level and will aim to remove the negative associations with handicap and replace it with the term 'participation'. The term 'disability' will be replaced by 'active limitation'. In the Social Model, impairment is the functional limitation within the individual caused by physical, mental or sensory impairment, and disability is the loss or limitation of opportunities to take part in the normal life of the community on an equal level with others due to physical and social barriers (WHO, 1997a).

The Americans with Disabilities Act of 1990 specifies that an individual has a disability if the person has a physical or mental impairment that substantially limits one or more major activities, has a record of such impairment, or is regarded as having such an impairment (Stiefel, 2002). Slade (1997) adapted the World Health Organization's classification of impairment, disability, and handicap into seven domains that impact on oral status of an individual: functional limitations, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap. Disabilities and impairments only become a handicap for a child if he/she is unable to carry out the normal activities of the peer group (Nunn, 1999).

The US Maternal and Child Health Bureau has defined children and adolescents with special health care needs as those "who have or are at increased risk for a chronic physical, developmental, behavioral, or emotional condition and who require health and related services of a type or amount beyond that required by children generally" (McPherson et al., 1998). People with special needs are those whose oral health care is complicated by a physical, mental or social disability (Davies et al., 2000). Children with special health care needs may be broadly defined as those children who are at risk for or who have ongoing physical, developmental, behavioural, or emotional disorders that require health care services beyond those needed by children without such a condition (Perrin et al., 1993; Allen, 1995).

Reference Manual of the American Academy of Pediatric Dentistry (1999) offers a definition of the dentally handicapped. A person should be considered dentally handicapped if pain, infection or lack of functional dentition restrict consumption of a diet adequate to support growth and energy needs, delays or otherwise alters growth and development, or inhibits performance of any major life activity, including work, learning, communication, and

recreation. Dentally handicapped refers to patients who have some gross condition or deficit in their oral cavities, which necessitates consideration for special dental treatment. By contrast, children who are 'handicapped for dentistry' are those who have a physical, mental or emotional condition that may prevent them from being treated routinely (Nunn, 1999).

Types of disability

Visual defects are one of the most common causes of disability in the world, and visual impairment in childhood is often part of a multiple disability disorder (Menacker & Batshaw, 2000). Sensory impairment can have a noticeable impact on an individual's ability to live independently. Vision may be the most important sense for interpreting the world around us; and when sight is impaired in childhood, it can have detrimental effects on physical, neurological, cognitive, and emotional development. Visual impairments vary from total blindness to slight limitations of size, colour, distance and shape (Nunn, 1999). Visual impairment is strongly related to age. Many individuals become blind through complications arising from various diseases of the eye, and from disorders such as cataract and glaucoma. In childhood, the causes of blindness are many; and the most common congenital causes are intrauterine infections, such as rubella and toxoplasmosis and malformations. The other causes among children include malnutrition, infectious diseases and parasitic infestations (Menacker & Batshaw, 2000).

Hearing impairment primarily influences communication, on which it can have a devastating effect (Champion & Holt, 2000). As the degree of loss increases, psychological, emotional and social disturbances generally become more pronounced. The extent of disturbance also depends on age of onset, training, and acceptance of disability. Hearing loss can result from both prenatal and postnatal infections, anoxia, prematurity, exposure to ototoxic agents and trauma (Champion & Holt, 2000).

Physical impairment, which is loss of voluntary movement in a part of the human body, is caused by disease or injury anywhere along the motor-nerve path from the brain to the muscle fibre and may result from injury, poisoning, infection, haemorrhage, occluded blood vessels, or tumours (British Society for Disability and Oral Health, 2000). Paralysis may be monoplegia, hemiplegia, paraplegia or quadriplegia. Cerebral palsy refers to a disorder of movement and posture that is due to a non-progressive abnormality of the immature brain. This disability might involve muscle weakness, stiffness, or paralysis; poor balance or irregular gait; and uncoordinated or involuntary movements. Individuals with physical impairment may have

reduced ability for self care and mobility problems which affect their ability to reach dental services and consequently their use of dental care (British Society for Disability and Oral Health, 2000).

Learning disability has been described as “a significant impairment of intelligence and social functioning acquired before adulthood” (Department of Health, 1998). The Individuals with Disabilities Education Act (IDEA, 1990) defines a learning disability as a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself as an imperfect ability to listen, think, speak, read, write, spell or do mathematical calculations.

Developmental disabilities are conditions that are identified in early childhood and usually persist throughout an individual's life. Medically, the etiologic factors of developmental disabilities are broad based and caused by a variety of conditions, including cerebral palsy, Down syndrome, mental retardation, autism, seizure disorders, hearing and visual impairments, congenital defects, and even social or intellectual deprivation. Conditions that may lead to special health care needs include Down syndrome, cleft lip/palate and other craniofacial defects, cerebral palsy, learning and developmental disabilities, emotional disturbances, vision and hearing impairments, diabetes, asthma, genetic and hereditary disorders with orofacial defects, or HIV infection (National Maternal and Child Oral Health Resource Center, 2000).

Mental retardation refers to “ significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behaviour and manifested during the developmental period” (Grossman, 1973). Mental retardation has been defined by The President' s Panel on mental retardation as “ a condition characterized by the faulty development of intelligence, which impairs an individual' s ability to learn and to adapt to the demands of society.” Mental retardation has been defined by the American Association of Mental Deficiency (AAMD) as “ Subaverage general intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behaviour” (American Psychiatric Association, 1994). Mental retardation can be defined as a deficiency in theoretical intelligence which is congenital or acquired in early life. The AAMD classifies retardation into four categories according to their intelligence quotient as mild, moderate,

severe or profound retardation. An individual is classified as having mild mental retardation if his or her IQ score is 50-55 to about 70; moderate retardation, IQ 35-40 to 50; severe retardation, IQ 20-25 to 35; and profound retardation, IQ below 20-25 (American Psychiatric Association, 1994).

First recognized in 1866 by Langdon-Down, Down syndrome (Trisomy 21) is a birth defect associated with an autosomal chromosome abnormality and is the most commonly known single cause of mental retardation. Down syndrome is also an easily recognized congenital anomaly characterized by generalized growth deficiency and mental deficiency. Along with anatomical abnormalities and physical and mental problems, orofacial problems have a large impact on individuals with Down syndrome and their guardians (Janerich & Bracken, 1986). Learning difficulties, abnormalities in immune response related to the increased prevalence of periodontal disease, short fingers, large palms, small but broad feet, are also reported in patients with Down syndrome (Saxen & Aula, 1982; Saenz, 1999).

Prevalence of disability

Disabilities affect a wide segment of the population of all ages and social classes. The prevalence of individuals with disabilities varies throughout the world. In the United States (U.S.), 2.6% of children below 3 years, 5.2% of children between 3 and 5 years, and 12.4% of young people between 6 and 21 years of age have disabilities (Waldman et al., 1999a; Waldman et al., 1999b). About 19 percent of U.S. children between 3 and 17 years of age or nearly 10 million children have emotional, learning, or developmental disorder (Waldman, 1991). Approximately 11 million children and adults in the U.S. have a disabling condition (Weddell et al., 2000). The Americans with disabilities (1991-92) report from the census bureau reported that 5.8 percent of children below 18 years of age, or 3.9 million children, have a disability (Waldman, 1995). An estimated 7.5 million people in the U.S. have mental disabilities (Shriver, 1998). Eighteen percent of U.S. children and adolescents aged 18 and under (or 12.6 million children and adolescents) have a chronic condition or disability (Newacheck et al., 1998). The prevalence of learning disabilities in the U.S. school-age population (6-17 years) has been estimated to be 4%-5%, making a total of about 2 million children (Roush, 1995).

It is estimated that in the United Kingdom (UK) over 6 million people are identified as disabled and about 360,000 children have disabilities. Learning disability has a prevalence of

about 2% of the UK population. The largest group with disability have a learning disability, which affects 6 in every 1000 births. It is estimated that that over one million people in the UK have a learning disability, ranging from mild impairment to about 200,000 with a severe or profound disability (Department of Health, 1998). About 3% of the population of children aged 16 and under are estimated to have one or more disabilities, of which more than a quarter have limitations affecting locomotion (Bone & Meltzer, 1989). However, mobility, which can be affected by different types of disability, affects a third of all children in communal establishments (Meltzer et al., 1989).

It has been estimated that 3 to 3.5% of children in the Nordic countries aged 0-15 years have a chronic disease or a long-standing disability (Storhaug et al., 1997). In Sweden, the number of children aged 0-19 years who were severely disabled was estimated at 15:1000. The prevalence of mental retardation in the Nordic population was estimated to be 1-3% (Storhaug et al., 1997).

Down syndrome (DS) affects about 1 in 600 to 1 in 1000 live births or occurs about once in every 600-1000 births (McGrother & Marshall, 1990). The prevalence of DS varies markedly depending on age of the mother when a child is born (Stoll et al., 1990), and the risk for DS seems to be strongly correlated with increase in maternal age (Alan, 1995). Since the 1970's, the prevalence of DS births has decreased from 1.33 per 1000 to 0.92 per 1000 presumably as a result of prenatal diagnosis (Down syndrome prevalence at birth, 1994).

Total visual impairment (blindness) affects more than 15 million people and will affect an estimated 30 million people by the year 2000 (Weddell et al., 2000). The prevalence of visual impairments, ranging from total blindness to slight limitation in vision, is 3 children in 1000 (Nunn, 1999). The overall incidence of blindness in children is about 1 in 3000; 46% of these children were born blind, and an additional 38% lost their sight before the age of 1 year (Menacker & Batshaw, 2000). The prevalence of deafness in children varies in different countries. In UK and in the Nordic countries 1-2 per 1000 schoolchildren need hearing aids (Storhaug et al., 1997). A 1994 estimate of the prevalence of hearing impairment in the U.S. was slightly less than 1 million or 1.8% of all youths under the age of 18 years. About 1 in 1000 infants is born with severe to profound hearing loss, and this incidence doubles during infancy and childhood (National Center for Health Statistics, 1994). Total hearing loss affects 1.8 million people, and there are 14 million hearing-impaired individuals in the U.S. (Weddell et al., 2000).

In industrialized nations, by school age the prevalence of cerebral palsy (CP) has remained reasonably constant at about 2 in 1000 live births (Paneth & Kiely, 1984). The overall prevalence of CP has for many years remained fairly constant at 1.4 - 2.4 per 1000 (Stanley et al., 1993). The incidence of cerebral palsy in the U.S., for all ages, is 1.5 to 3 cases per 1000 individuals (Weddell et al., 2000).

In Kuwait, the prevalence of DS is high compared to European western countries. The incidence was 1.71, 1.74, 2.21 and 2.32 per 1000 live births in the years 1997, 1998, 1999 and 2000 respectively (Al-Awadi, 2002). The incidence of DS has been estimated to be 1.1/1000 live births (El-Alfi et al., 1968; Mahfauz et al., 1987) and to range from 0.3 to 3.4 per 1000 births (Al-Awadi et al., 1987; 1990). A high incidence of DS has been demonstrated among the Bedouins (3.6/1000), with marked temporal variations between the Jahra and Farwaniya districts in Kuwait (Frag et al., 1988; Frag & Teebi, 1988). A previous study from Kuwait, which has a high consanguinity rate (Al-Awadi et al., 1985), showed that DS was about 4 times more frequent among children of closely related parents than among those with unrelated parents (Alfi et al., 1980). In Kuwait, there is no national data on the prevalence of individuals with various other disabilities.

Effects of disability

The effects of disabling conditions are many, but one of the most common is the inability of the individual to maintain oral health. The oral health of children and adolescents with special health care needs may be affected negatively by the medications, therapies or special diets they require, or by their difficulty to clean their teeth thoroughly on a daily basis (Casamassimo, 1996). Oral health care is an important factor in the maintenance of good oral hygiene and can be difficult for the person with a disabling condition, as they often rely on others for assistance. Disabled children also face a particular risk from dentally unsafe dietary practices (Palin-Palokas et al., 1987; Randell et al., 1992). In addition, many conditions and disabilities are associated with increased risk for various oral health problems. Dental caries, periodontal disease and other oral conditions, if left untreated, are impairments that can substantially limit a child's development and an individual's participation in the main activities of life. Dental disease is a major health problem for people with disabilities. According to many epidemiological studies, persons who are disabled have more oral health problems than the rest of the population (British Society for Disability and Oral Health, 2000; 2001). Disability or illness can directly or indirectly increase the need for oral health care. Although in the Nordic

countries, the general policy goal for persons with disabilities is their virtual integration into general society, it was found that individuals with mental retardation received less dental care than the rest of the population. Due in part to inefficient recall systems and practical difficulties associated with treatment situations, treatment consisted mainly of extractions (Haavio, 1995).

The oral health of people who are visually impaired can be disadvantaged, since they are not in a position to detect and recognize early oral disease and may be unable to take immediate action unless informed of the situation. The individual's ability to cope with everyday tasks of personal hygiene, including oral hygiene, is critical to the maintenance of an independent existence (Schembri et al., 2001). Upper limb disability may affect an individual's ability to manage effective oral hygiene. Poor oral hygiene and periodontal disease have been reported in a sample of paraplegics (Steifel et al., 1993; Lancashire et al., 1997).

The group with developmental disabilities present specific challenges when their oral health is assessed because of their reduced level of function and their ability to undergo an oral examination (Tesini, 1981). Coping with conditions, which interfere with a child's intellectual development, are often a great challenge to the dental profession. Children and adolescents with developmental disabilities are at high risk for enamel irregularities, gum infections, delays in tooth eruption, moderate to severe malocclusion, and oral infection (Isman & Newton, 1997). Children and adolescents with cleft lip/palate are at increased risk for dental caries, gingivitis, cross bite and crowding (Mitchell & Wood, 2000). Variables such as age, degree of mental retardation, institutionalization and oral hygiene status have been shown to influence the prevalence and severity of oral disease, dental access and care patterns in patients with mental retardation (Tesini, 1980).

Children and adolescents with DS have a high incidence of periodontal disease, xerostomia, fissuring of the tongue and lips, and malocclusion (Pilcher, 1998). It has been shown that the population with DS has increased prevalence and severity of periodontal disease compared to those of with no mental or physical handicap (Cutress, 1971b; Orner, 1976; Vigild, 1985a; Barnett et al., 1986; Reuland-Bosma & van Dijk, 1986; Desai, 1997; Seymen et al., 2002). Cross-sectional as well as longitudinal studies indicate that the prevalence of periodontal diseases in persons with DS who are under the age of 30 years is extremely high and can even be seen in the deciduous dentition (Reuland-Bosma & van Dijk, 1986). Even when a good standard of oral hygiene is maintained, children with this disability are susceptible to a more generalized aggressive form of periodontitis due to immunodeficiency; this results in bone loss

and deep pocketing, and the severity of the disease is mainly due to poor oral hygiene and changes in the connective tissues of the gums (Scully, 1976; Forsberg et al., 1985). Children with DS are further disadvantaged by poor preventive dental health practices and should therefore be especially targeted for increased preventive dental care (Randell et al., 1992). Given the degree of orofacial dysmorphology, dysfunction and disease, it is logical that people with DS would benefit from specific preventive programmes of oral health and good access to a dental setting (Allison et al., 2001).

Many parents lack the confidence to perform oral hygiene care for their disabled child because they do not have enough information about their child's dental growth and development (Isman et al., 2000). This fact may be part of the overall parental neglect of these children in relation to other basic health measures or may reflect the attitude that oral health is not important in the overall scheme of health management. It is common that the most frequently neglected facet of home health care for the non-institutionalized disabled children is dental care (Nowak, 1984).

Barriers to oral health

People with special needs have been described as those who encounter more barriers to the receipt of dental care than other people. They may have greater problems accessing dental care or may be at increased risk from dental disease or its treatment (McAlister & Bradley, 2003). The barriers to oral health that people with disabilities experience vary according to age and the level of parental or social support received, and change throughout life depending on particular problems associated with transitional periods (British Society for Disability and Oral Health, 2001). Oral health may have a low priority in the context of pressures, like illness and disabilities, that are more life threatening (Ohmori et al., 1981). Barriers to accessing and using dental services include lack of perceived need, inability to express need, and lack of ability to provide self-care (Kendall, 1992). Problems of physical access to health service premises, including dental surgeries are reported in individuals with a physical impairment (Wilson, 1992). Moreover, the attitudes to oral care and the knowledge of health professionals and health care workers have been identified as barriers to oral health for individuals who are dependent on others for oral hygiene (Boyle, 1992). The majority of individuals with disabilities have poor verbal skills and are restricted in their ability to communicate their needs. It may be harder to discuss and resolve fear and anxiety, which are the most common barriers to dental care in these individuals; and inability to cooperate with treatment needs leads to a greater need for behaviour management techniques, conscious sedation and general anaesthesia

than for the general population (Forsberg et al., 1985; Davies et al., 1988; Nunn et al., 1993; Gordon et al., 1998; Connick & Barsley, 1999).

Oral health status among the disabled

Researchers throughout the world have studied a wide range of disabling conditions. Although the level of oral health in the western countries has increased, no comparable improvement has taken place in the disabled. Many studies (Appendix 1, 2, 3) have shown that the oral health of individuals who are disabled is poorer and their oral treatment needs are greater than those of the general population (Cutress, 1971a, b; Murray & McLeod, 1973; Brown & Schodel, 1976; Tesini, 1981; Mann et al., 1984; Storhaug, 1985; Shaw et al., 1986; Nunn, 1987; Nunn & Murray, 1987; Storhaug & Holst, 1987; Vignesha et al., 1991; Ohito et al., 1993; Bhavsar & Damle, 1995; Gizani et al., 1997; Martens et al., 2000; Mitsea et al., 2001; Seymen et al., 2002). There is evidence that physically disabled individuals also experience poorer oral health (Francis et al., 1991; Nunn et al., 1993; Lancashire et al., 1997). Children attending special needs schools are reported to have received little preventive care (Costello, 1990). Reviews of epidemiological studies have indicated that persons with disabilities generally have more oral health problems than the rest of the population (Brown & Schodel, 1976; Tesini, 1981; Beck & Hunt, 1985; Nunn, 1987). The disabled also experience barriers to achieving good oral health and accessing appropriate dental services (Nunn & Murray, 1990; Wilson, 1992; Russell & Kinirons, 1993; Griffiths & Trimlett, 1996; Lester et al., 1998).

Dental caries experience among the disabled

According to the recently released Surgeon General's report, dental caries continues to be the most common infectious disease of childhood (U.S. Department of Health and Human Services, 2000a). Dental caries is also the major cause of tooth loss in individuals with physical and mental disabilities.

Several studies (Appendix 1) have noted that disabled subjects have higher levels of caries, lower levels of care and a much higher proportion of untreated lesions but less treatment than the normal population (Swallow, 1968; Cutress, 1971a; Murray & McLeod, 1973; Brown & Schodel, 1976; Tesini, 1981; Naoh, 1982; Palin-Palokas et al., 1982; Maclaurin et al., 1985a; Storhaug, 1985; Jones & Blinkhorn, 1986; Shaw et al., 1986; Nunn, 1987; Nunn & Murray, 1987; Storhaug & Holst, 1987; Vignesha et al., 1991; Gupta et al., 1993; Ohito et al., 1993;

Gizani et al., 1997; Mitsea et al., 2001). In children with mild learning disabilities and children who are partly independent, prevalence of dental caries is also higher (Palin-Palokas et al., 1982; Storhaug & Holst, 1987). It would appear that these children may have fewer dietary restrictions and are therefore at greater risk for dental caries. While the overall caries experience as measured using the DMF index may be similar for disabled and normal children, there is often more untreated decay, more missing and fewer filled teeth in the disabled (Nunn, 1999). Historically, people with impairments tended to have more teeth extracted and fewer teeth restored (Nunn, 2003). A higher 'D' component of the caries experience index (DFS) has been reported in the intellectually disabled children in Finland (Palin-Palokas et al., 1982). Although a greater proportion of disabled children were caries-free, of those needing treatment, more required extractions (Pool, 1982).

With regard to number of teeth and time of eruption, mentally retarded children without Down syndrome are comparable to normal children and have similar caries experience (Vigild, 1986). It would seem that overall the prevalence of dental caries in the mentally handicapped is similar or lower than that found in normal populations (Nunn, 1996). Stricter dietary control may have contributed to lower caries prevalence in institutions (Schwartz & Vigild, 1987).

Many studies have been undertaken with the purpose of investigating the oral health of individuals with Down syndrome, and prevalence of dental caries has frequently been reported. Caries results for individuals with Down syndrome are conflicting. Historically the prevalence of dental caries in people with Down syndrome has been reported to be low compared to either other mentally handicapped or normal children (Brown & Schodel, 1976). The majority of the studies showed a decreased caries prevalence in individuals with Down syndrome compared with controls (Johnson et al., 1960; Brown & Cunningham, 1961; Winer & Cohen, 1962; Cohen & Winer, 1965; Creighton & Wells 1966; Wolf, 1967; Cohen & Cohen, 1971; Cutress, 1971a; Steinberg & Zimmerman, 1978; Barnett et al., 1986; Stabholz et al., 1991; Pueschel & Pueschel, 1992; Morinushi et al., 1995; Aküz et al., 1997). Most studies reporting a lower caries experience in Down syndrome were of institutionalized populations; other studies that demonstrated little or no difference in their caries experience compared with other groups generally consisted of Down syndrome children living at home.

It has been suggested that the difference in caries prevalence is not related to any specific inhibitory factor but rather to the combined factors of delayed tooth eruption, altered tooth morphology and increased prevalence of congenitally missing teeth in children with Down

syndrome (Cutress, 1971a). Living environment, dietary and hygiene habits (Swallow, 1964; Kroll et al., 1970; Takeda et al., 1989), fewer erupted teeth due to a high frequency of hypodontia, later eruption patterns (Swallow, 1964; Cutress, 1971a; Vigild, 1986) and different proportions of salivary components compared to normal children (Cohen & Winer, 1965; Vigild, 1986; Jara et al., 1991) have been proposed as causes for the low prevalence of caries rate in Down syndrome. Individuals with Down syndrome are susceptible to caries, even though the prevalence of approximal caries is low, probably mainly due to the fact that subjects with Down syndrome have more spacing (Vigild, 1986). Morinushi et al. (1995), who evaluated the status of dental caries and relationship between dental plaque or caries experience and serum antibody titers against *S. mutans* and *S. mitis*, stated that it was not clear whether antibodies are protective and responsible for the reduced caries rate seen in Down syndrome.

In some studies, caries occurrence has been shown to be higher (Kroll et al., 1970; Rosenstein et al., 1971; Gupta et al., 1993) or no different (Swallow, 1964; Gullikson, 1973; Steinberg & Zimmerman, 1978; Maclaurin et al. 1985c; Vigild, 1986; Ulseth et al., 1991; Yarat et al., 1999; Seymen et al., 2002) in a group with Down syndrome compared with a normal group without Down syndrome.

The observations of lower caries prevalence in persons with Down syndrome have been questioned, and caries prevalence in patients with Down syndrome and non-Down syndrome patients with mental retardation was reported to be similar (Swallow, 1964). Likewise, the dental caries rate in the Down syndrome patients did not appear to be lower than in those without Down syndrome (Kroll et al., 1970). Steinberg & Zimmerman (1978) found no difference in the number of decayed, missing and filled teeth, whereas the number of decayed, missing and filled surfaces was significantly lower in children with Down syndrome compared to another group of children with mental retardation. Among three genotypes (Trisomy-21, Translocation, and Mosaicism) for Down syndrome, no difference in caries experience has been reported (Latner, 1983). In caries experience of permanent dentitions there were no significant differences between Down syndrome and normal children (Maclaurin et al. 1985c). Yarat et al. (1999) studied subjects 6-24 years of age with and without Down syndrome and found no significant differences in caries prevalence between age groups. In a recent study, it was concluded that the caries prevalence of children with Down syndrome was similar to that of healthy children (Seymen et al., 2002).

Oral hygiene and periodontal conditions among the disabled

Oral hygiene and periodontal disease represent a major problem for the disabled; however, lack of conformity in the use of indices makes valid comparisons difficult (Nunn et al., 1987). Children with disabilities tend to have poor standards of oral hygiene and plaque control, more gingivitis, and greater prevalence and severity of periodontal disease than normal children (Cutress, 1971b; Murray & McLeod, 1973; Brown & Schodel, 1976; Tesini, 1981; Naoh, 1982; Mann et al., 1984; Shaw et al., 1986; Nunn, 1987; Nunn & Murray, 1987; Vignesh et al., 1991; Ohito et al., 1993; Bhavsar & Damle, 1995; Gizani et al., 1997; Martens et al., 2000; Mitsea et al., 2001; Seymen et al., 2002) (Appendix 2). The majority of studies agree that children who are disabled are in far greater need of treatment than normal children are. Their lack of motivation, low concentration, and problems with manual dexterity make it extremely difficult to achieve and maintain a high standard of oral hygiene and gingival health (Brown et al., 1980).

Comparison between studies is difficult because of the lack of common indices; but in general, oral cleanliness is less adequate and deteriorates more with age in subjects with mental retardation, Down syndrome and cerebral palsy (Murray & McLeod, 1973; Maclaurin et al., 1985b; Pope & Curzon, 1991; Ohito et al., 1993). Reviews of epidemiological studies reported that children with disabilities tended to have poorer oral hygiene and a greater prevalence and increased severity of periodontal disease than their normal counterparts (Brown & Schodel, 1976; Tesini, 1981; Nunn, 1987). Despite improvements in dental caries with programmes of enhanced provision of service, there has been virtually no improvement in gingival health and periodontal conditions (Costello, 1990; Holland & O'Mullane 1990; Evans et al., 1991). Studies have indicated that children with learning disabilities have more plaque and greater severity of gingivitis than the general population; and these problems increase markedly with increasing age, and the poorest periodontal health is found in 16-19 year-olds (Vigild, 1985a; Nunn, 1987).

Upper limb disability may affect an individual's ability to manage effective oral hygiene. Poor oral hygiene and periodontal disease has been reported in a sample of paraplegics (Stiefel et al., 1993; Lancashire et al., 1997). Deteriorating gingival health, as well as increased prevalence of

gingivitis with increasing age, was observed in children with cerebral palsy who have a mental disability (Pope & Curzon, 1991).

Oral hygiene was poor and periodontal disease was generally found to be prevalent among individuals with mental retardation, especially if they were institutionalized (Smith et al., 1966; Swallow, 1966; Butts, 1967; Winer, 1969; Svaton & Helöe, 1975; Clemens et al., 1977; Brown, 1980; Tesini, 1980; Nunn & Murray, 1987). There was however, no significant correlation between manual dexterity and comprehension scores and the periodontal indices in adults who were mentally retarded (Shaw et al., 1989).

Individuals with Down syndrome demonstrate a high prevalence of periodontal diseases (Barnett et al., 1986; Desai, 1997). A review of literature concerning dental abnormalities and diseases in persons with Down syndrome consistently shows an increased frequency of periodontitis compared with that of other patients with mental retardation (Swallow, 1964; Kroll et al., 1970; Cutress, 1971b; Gullikson, 1973; Miller & Ship, 1977; Saxen & Aula, 1982; Forsberg et al., 1985; Vigild, 1985a; Barnett et al., 1986; Ulseth et al., 1991) as well as compared with that of the population in general (Cutress, 1971b; Forsberg et al., 1985; Reuland-Bosma & van Dijk, 1986; Reuland-Bosma et al., 1986). Several cross-sectional studies have reported a higher prevalence and severity of periodontal disease in children of older groups (Cohen et al., 1961; Johnson & Young 1963; Sznajder et al., 1968; Cutress, 1971b). Longitudinal studies indicated that the progression of disease is especially rapid, in the younger age groups (Miller & Ship, 1977; Brown, 1978; Saxen & Aula, 1982). Even when a good standard of oral hygiene is maintained, gingivitis and periodontal disease are more severe in children with Down syndrome (Forsberg et al., 1985).

Swallow (1964) studied children with Down syndrome and mental retardation in three different environments and found that within the same environment the prevalence of periodontal disease was higher in the group with Down syndrome and also that institutionalized children with Down syndrome had a higher prevalence and severity of periodontal disease than did those residing at home. It was concluded that a systemic factor related to the syndrome combined with an environmental factor increases the susceptibility of the individuals with Down syndrome to periodontal disease (Cutress, 1971b). The greater severity of periodontal diseases has been attributed to factors such as lower resistance to bacterial infection, malocclusion, traumatic occlusions, tooth morphology, and lack of normal mastication (Scott et al., 1998).

Malocclusions among the disabled

The muscles of the face and oral cavity play a role in facial growth and occlusal development (Houston et al., 1992). An early study by Rhodes (1884) led to the conclusions that a group of patients with mental retardation had ill-formed maxillae, more over-crowding than usual and much smaller inter-canine widths than in the normal population. In their literature review, Brown & Schodel (1976) found that, except for Down syndrome and severe cerebral palsy, there was no evidence that malocclusion was common amongst the disabled.

Several studies (Appendix 3) have reported higher prevalence of malocclusion in those with disabilities than in the normal population (Swallow, 1964; Cohen & Winer, 1965; Kisling, 1966; Gullikson, 1969; Rosenstein et al., 1971; Gullikson, 1973; Vigild, 1985b; Nunn, 1987; Nunn & Murray, 1987; Orelan et al., 1987; Strodel, 1987; Pope & Curzon, 1991; Vignesha et al., 1991; Ackerman & Wiltshire, 1994; Franklin et al., 1996; Mitsea et al., 2001). Many of these malocclusions affect normal chewing patterns and may cause mouth breathing, which leads to drying of the oral tissues.

Some investigators have found an increased prevalence of malocclusion in subjects with cerebral palsy (Lyons, 1960; Album et al., 1964; Foster, 1974; Strodel, 1987; Pope & Curzon, 1991; Franklin et al., 1996; Mitsea et al., 2001). The frequency of malocclusions has been reported to be higher in children and adults with neuromotor handicaps than in healthy individuals (Album et al., 1954; Koster, 1956; Orelan et al., 1987). Those with cerebral palsy tend to have a much higher prevalence of extreme maxillary overjet, Angle's class II malocclusion with crowding and cross bite because of hypertonicity, tongue thrust and constriction of dental arches (Nunn, 1987). Pope & Curzon (1991) postulated that poor swallowing and other abnormal muscle activity might have contributed to the increased overjet in children with athetoid cerebral palsy. As the tone and function of the orofacial muscles with cerebral palsy can be abnormal, the facial growth and occlusion of these children may be outside normal limits. The extent of malocclusion was reported for a group of cerebral palsy patients in whom those with athetosis and spasticity showed the highest frequency of malocclusions (Koster, 1956). The degree of malocclusion is influenced by the severity of the neuromuscular incompetence of the head and neck (Koster, 1976). In children with cerebral palsy there is a tendency toward increased overjet, overbite and incompetent lips (Franklin et al., 1996); and in children with athetoid cerebral palsy there is often a class II division 2-type

incisor relationship (Kanar, 1979). The high frequency of malocclusions in the cerebral palsy group may be explained not only by differences in their basic neuromotor handicap, but also by the predominance of more severely mentally retarded individuals (Koster, 1976; Rosenstein, 1978).

An increased prevalence of malocclusion has been noted in subjects with Down syndrome (Brown & Cunningham, 1961; Swallow, 1964; Cohen & Winer, 1965; Gullikson, 1973; Girgis, 1985; Vigild, 1985b; Nunn, 1987; Orelan et al., 1987; Vignesh et al., 1991). One of the most striking features of the faces of children with Down syndrome is the relative under-development of the middle third of the face and the consequent tendency toward a class III skeletal-base relationship. Increased prevalence of malocclusion in persons with Down syndrome has been reported previously and has been associated with under-development of the maxilla and Angle's Class III malocclusions (Brown & Cunningham, 1961; Nunn, 1987).

Many researchers cite a tendency toward Angle's class III malocclusion in subjects with Down syndrome, together with a posterior crossbite (Brown & Cunningham, 1961; Cohen & Winer, 1965; Gullikson, 1973; Vigild, 1985b; Nunn, 1987). Along with other intra-oral anomalies, a common finding is a high vaulted palate (McMillan & Kashgarian, 1961; Harvey-Brown, 1965; Parkin et al., 1970; McIver & Machen, 1979). In subjects with Down syndrome the prevalence of crossbite has been reported (Cohen & Winer, 1965; Gullikson, 1973), as well as an openbite (Brown & Cunningham, 1961; Cohen & Winer, 1965; Gullikson, 1973). Anterior and posterior crowding has also been reported previously (Brown & Cunningham, 1961).

Traumatic injuries among the disabled

In a society that increasingly places emphasis on improved dental health and awareness of appearance, injury to the anterior teeth of young children is an emotional as well as physical experience for both children and parents (Nicholas, 1980). Traumatic injuries to the teeth are among the most serious dental conditions and are particularly important because of the critical sensory, communicative, gustatory, and psychosocial functions of the teeth and mouth (Kaste et al., 1996). Fracture of the anterior teeth is a common result of trauma to the face. Children, for both behavioural and anatomic reasons, most frequently sustain traumatic injuries to the anterior teeth (Konis, 1991). Epidemiological studies of traumatic injuries are few, and the results of such studies vary greatly. Differences in the classifications of traumatic injuries account for the differences in the prevalence of traumatic injuries. It has been shown that traumatic injuries are more prevalent in the disabled than in normal children (Greeley et al.,

1976; Nunn & Murray, 1987; Costello, 1990; Ohito et al., 1992; Denloye, 1996) (Appendix 3.) Children who are disabled are a well-established group of children who need greater supervision and are more prone to traumatic injuries (Wei, 1988). Like other oral health conditions, traumatic dental injuries are preventable, and preventive measures can only be applied when factors that contribute to the injuries have been identified (Ohito et al., 1992).

Dental fluorosis among disabled

Dental fluorosis is a specific disturbance of tooth formation due to excessive ingestion of fluoride (Moller, 1982). One of the major sources of fluoride ingestion is drinking water (Moller, 1982). Other sources include beverages (Pang et al., 1992), toothpastes (Bentley et al., 1999; Zohouri & Rugg-Gunn, 2000), infant formula and fluoride supplements (Osuji et al., 1988). In addition, certain foods contain considerable amounts of fluorides (Taves, 1983). Endemic dental fluorosis has been reported in different parts of the world where drinking water contains excessive amounts of fluoride (Dean et al., 1942; Thylstrup & Fejerskov, 1978; Warnakulasuriya et al., 1992). Dean et al. (1942) observed dental fluorosis in temperate areas of the USA with fluoride levels in drinking water in excess of 2 ppm and occasionally even in areas with lower fluoride levels. In the past, dental fluorosis was found almost exclusively in endemic areas where drinking water was the source of excessive fluoride intake. However, the condition is now known to occur more frequently in populations where the drinking water contains very low fluoride concentrations; this has been attributed to several risk factors, including the widespread use of fluoride toothpastes (Leverett, 1986).

The prevalence of dental fluorosis is on the increase in many parts of the world, and this may be due to the increased use of fluoride in preventive dentistry (Akpata, 2001). Studies in different parts of the world have demonstrated that fluoride exposure of about 1ppm in temperate countries reduces caries experience by 50 to 60%, with minimum fluorosis (Dean et al., 1942; McClure, 1970; O'Mullane et al., 1988). The prevalence of dental fluorosis has not been studied widely among the disabled, and there is only one epidemiological study on this topic (White et al., 1998). In that study the prevalence of fluorosis was 6.3% among mentally disabled special Olympic athletes.

Oral hygiene interventions among the disabled

The early targeting of special needs groups is fundamental to the success of any programme of prevention (Nunn, 1996). Borutta & Heinrich (1992) concluded that patients who are disabled should receive regular prevention-oriented dental care beginning at the age of 3 years. The key to success in any therapy programme is the consistency of its delivery and the early involvement of parents so that they can learn to manage their child at home (Miller et al., 1995). Particularly for children with special needs, long-term reinforcement and cooperation between parents and teachers is necessary to facilitate learning and the transfer of newly learned concepts and skills to the home environment (Palin-Palokas, 1997). Oral care of children and adolescents with impairment is of particular importance and should aim at prevention as the basis for good oral health throughout life. The important factor for effective delivery of dental care is the way in which the individual's disability is approached (Evans et al., 1991; Nunn et al., 1993). Unfortunately, some parents who perceive a need for dental care want curative treatment rather than preventive procedures (Lo et al., 1991). An important feature of oral diseases is that effective methods of prevention that are simple and cheap are available, but in many cases these methods are not applied appropriately (Sheiham, 1993). Different preventive programmes have been tested especially with children who are disabled, as their higher risk for caries and periodontal diseases has been known. The results from a comprehensive preventive programme for disabled children have been positive (Brown, 1975). It could be assumed that most of the preventive methods that have been shown to be effective with normal children would also be effective with disabled children.

The oral hygiene status of individuals with disabilities tends to have specific problems that affect their ability to perform oral hygiene; these problems include manual dexterity, coordination, self-help skills, and the ability to comprehend complex tasks. Hence maintenance of oral hygiene remains the outstanding challenge in the care of disabled patients. Physical and/or mental disabilities are known to compromise hygiene habits, including oral hygiene, either directly or indirectly (British Society for Disability and Oral Health, 2000; British Society for Disability and Oral Health, 2001). Many children with disabilities are unable to clean their teeth adequately due to some mental and/or physical problem. Moreover, a child may have involuntary hand and arm movements or may be partially or totally paralyzed, thus making it difficult to control or grip a toothbrush; and others have problems due to the fact that braces or artificial limbs cause restricted movements. Obviously, many individuals who are disabled find the maintenance of their own oral hygiene much more difficult than non-disabled

individuals do. Because of the problems of motivation and manual dexterity, achievement and the maintenance of a high standard of oral hygiene and gingival health in disabled children and adults can be extremely difficult (Brown, 1980). In a questionnaire study of children with Down syndrome, Randell et al. (1992) found that children with Down syndrome have poorer dental health practices than normal children do. If emphasis is not placed on prevention at follow-up, many children who are disabled are further disadvantaged by poor preventive dental practices or non-maintenance of comprehensive restorative care (Mitchell et al., 1985). To postpone the onset of periodontal disease in patients with Down syndrome, optimal oral hygiene is therefore of particular importance (Vigild, 1985a).

Some children who are retarded are not mentally capable of understanding procedures for cleaning the teeth. However, when the child is unable to maintain optimal oral hygiene, it is necessary for another individual to assume this responsibility (Albertson, 1974). As a majority of individuals with disabilities cannot perform the necessary techniques for plaque removal, oral hygiene for these individuals generally becomes the responsibility of another person, usually a parent, guardian or institutional aide. Indeed in disabled individuals it is not unusual for oral hygiene to be delegated to a parent, guardian or other caregiver (Francis et al., 1987). The lack of oral hygiene in subjects with disability has been attributed to their inability to clean their oral cavity properly (Johnson & Albertson, 1972). Those who are dependent for oral hygiene rely on the knowledge and skills of their caregivers, and some studies demonstrate chronic inadequate oral hygiene practices delivered by health care workers (Boyle, 1992).

Depending on the severity of the mental or physical handicap, overall hygiene care tends to be prioritized and may be influenced by the experience, ability and available time of the caregivers. Studies of individuals with handicaps have usually revealed dental health and gingival problems with significantly poorer oral hygiene than in the non-handicapped (Morten, 1977; Melville et al., 1981; Lanchashire et al., 1997). For this reason it has been recommended that patients, parents, and care staff require, from an early stage, dental health education and active involvement in prevention programmes (Scottish Home & Health department, 1984). Motivation and the senses, particularly that of touch, must be utilized when the blind are instructed in oral hygiene methods (Greeley et al., 1976).

The first choice for control of bacterial plaque is mechanical. Some studies (Reynolds & Block, 1974; Sauvetre et al., 1995; Carr et al., 1997) of persons with disabilities have shown that it was possible to produce statistically significant reductions in plaque and gingival indices

through mechanical control of plaque. Toothbrushing is the principal method used for maintaining oral hygiene. Moreover, toothbrushing and its appropriate frequency are simple and effective ways of reducing levels of plaque and gingivitis (Addy et al., 1990). Dental health education for children has long emphasised the toothbrushing habit, and a continuous trend towards more frequent performance of dental hygiene practices has been reported (Honkala et al., 1991). Removal of plaque from teeth is a skill that can be mastered only when an individual has the dexterity to manipulate a toothbrush and an understanding of the objectives of this activity (Pinkham, 1975). The basic hypothesis of adopting the healthy toothbrushing habit is that after establishment, individual variation is minimal and generally improves. It is important that school-age children learn to adopt oral hygiene habits that are conducive to improved periodontal status in later life (Macgregor & Balding, 1987).

Research on provision of dental care for children with disabilities has recognised the importance of regular plaque removal as part of the preventive programme (Melville et al., 1981). Various studies have suggested the use of different people who may help with such work, such as a dental therapist in a school toothbrushing programme (Brown, 1980), a dental hygienist in long-stay hospitals (Rippon, 1980), and the teachers at schools (Price, 1978). For any school dental programme to be successful it must include the role of parents; and greater involvement of teachers in oral health education has been advocated (Price, 1978). Unfortunately, many programmes have concentrated on involving others in providing basic toothbrushing skills, rather than attempting to teach these skills to the children (Albino, 1979).

Oral hygiene can be improved significantly by providing intensified daily brushing by dental personnel, by developing of self-help workshops, by providing effective staff training, or by a combination of all these approaches (Nicolaci & Tesini, 1982). Reports on programmes of oral health maintenance in institutional residences are based primarily on studies designed to test the effectiveness of training the direct-care staff in proper oral hygiene techniques (Nicolaci & Tesini, 1982). To introduce the concept of prevention as a solution to problems of dental disease in handicapped patients, it has been suggested that a series of workshops be scheduled for staff members during working hours (Casamassimo & Nowak, 1977). Albertson & Jackson (1973) advocated workshops that would include demonstrations reinforced with audiovisual aids; and step-by-step demonstrations were given to small groups of staff members to teach preventive techniques, such as positioning, disclosing, toothbrushing, flossing, fluoride applications, and nutritional counselling. When used by trained teachers, professionally made videos designed for children with mental handicaps can be useful and valuable aids in

educating children of different levels of mental and social development about oral health (Palin-Palokas et al., 1997).

Oral hygiene maintenance has been given some attention in several short-term studies. It has been shown that after initial prophylaxis and 60 days of toothbrushing twice daily by senior dental students, the severity of periodontal disease decreased (Goyings & Rieske, 1968). Although periodontal disease is a major health problem for the handicapped, institution of proper oral hygiene care has improved gingival health among this population (Goyings & Riekse, 1968). Others have searched for the most effective method to motivate and train direct care staff in proper hygiene techniques (Gertenrich & Hart, 1972; Full et al., 1977; Price, 1978; Willette & Savage, 1978). Four weeks after each attendant was individually instructed, using as a model the handicapped child rather than a model of a dentition for demonstration, decrease in Oral Hygiene Index (OHI) scores was found (Full et al., 1977). In a three-month study, it was found that there was a 53% improvement in oral hygiene among an experimental group consisting of residents who, when possible were taught self-brushing by other residents and dental assistant students (Gertenrich & Hart, 1972).

Although toothbrushing can cause considerable manipulative difficulties among some disabled populations, with proper training, many disabled individuals are able to carry out toothbrushing procedures themselves. Toothbrushing programmes have been shown to be effective in improving the oral hygiene and gingival health of various disability groups (Russell & Bay, 1978; Schwartz et al., 1978; Albino et al., 1979; Brown et al., 1980; Leary & Zucker, 1981; Nicolaci & Tesini, 1982; Vigild, 1985; Ohito et al., 1993). It was demonstrated that withdrawal of toothbrushing in individuals with healthy gingivae and excellent oral hygiene resulted not only in rapid accumulation of debris in the teeth, but also in the development of marginal gingivitis; when proper oral hygiene was reinstated, however, the process was reversible. Even severely handicapped children can be instructed in toothbrushing if they are motivated and encouraged (Nicolaci & Tesini, 1982; Shaw et al., 1983; Holland & O'Mullane, 1986). The poor oral hygiene status could be due to limitations in personal abilities or technical difficulties (e.g. the inability to hold the toothbrush), but there is a strong feeling that nurses and caregivers are more interested in general hygiene than in oral hygiene (Mann et al., 1984).

In a school programme of supervised toothbrushing for non-institutionalized children with mental retardation with or without Down syndrome, the prevalence of severe gingivitis was lowest and the periodontal health was best among those who brushed teeth every day under teacher supervision (Vigild, 1985).

Education and implementation of oral health practices are especially important in preventing dental diseases in children who are disabled and living at home. Routine checkups (recall visits) at a dental clinic familiar with the child also promote oral health in disabled children (Price, 1987; Maurer et al., 1996). However, few reports have described the relationship between oral findings in children who are disabled and the behavioural aspects of oral health care (Price, 1978; Borutta & Heinrich, 1992). The specific circumstances of public dental care and personal care in the community are also important factors for the oral health of disabled children who are in need of assistance (Morinushi et al., 2001). Improvements in dental health were observed in a comprehensive system of dental prevention and treatment undertaken by the community dental service (Mellor & Doyle, 1987). Similar improvements in dental health could be achieved through mobile dental facilities used by community dental services (Evans et al., 1991).

In some disabled groups, effective measures that are easily acceptable are needed, as it is difficult to achieve and maintain acceptable levels of oral hygiene among this population using only conventional methods of plaque control (Francis et al., 1987). Chemical control of plaque could offer some advantages in disabled groups, as the maintenance of oral hygiene is a major problem (Francis et al., 1987). Chemical control of plaque is indicated in conjunction with mechanical control only when mechanical control proves ineffective (Tesini & Fenton, 1994). However, Sheiham (2000) asserts that, when the objective is to prevent severe periodontitis for the population in general, chemical methods are not necessary to prevent gingivitis.

Chemical intervention requires only passive involvement and less dexterity from the children. Chlorhexidine has been used in special needs groups as an aid to or replacement for oral hygiene measures and in a group of physically and mentally handicapped adults 0.2% chlorhexidine spray was used as an adjunct to toothbrushing (Kalaga et al, 1989). Chlorhexidine spray, potentially easier to use in disabled populations than other vehicles, also produces significant reductions in periodontal scores (Francis et al., 1987; Chitke et al., 1991). Significant reductions in plaque and gingival indices were also reported in studies using chlorhexidine mouthwash (McKenzie et al., 1992). The chlorhexidine rinse may be used

successfully in children with a physical disability; however, simple improvement in oral hygiene might produce the same effect (Laher & Cleaton-Jones, 1996). Chlorhexidine swabbing was found to be effective in oral health care of individuals with severe disabilities (Stiefel et al., 1992). The use of chlorhexidine in a sustained-release dosage form applied to tooth surfaces may prove useful in the control of plaque in children with Down syndrome (Stabholz et al., 1991b). Topical antimicrobial agents, such as chlorhexidine and arginine sustained-release varnishes, may be useful for plaque control among patients with mental retardation (Shapira et al., 1994). In general, chemical interventions have been used more often in the institutionalized disability groups, who are incapable of plaque control or maintaining oral hygiene, themselves.

Prevalence of disability is changing in different countries and cultures, and oral health as well. This reflects both biological factors and emphasis of the health care system for controlling these. Sophisticated medical care with advances in medical science and new medical interventions, which prolong life, coupled with demographic changes in the age of the population suggest that the prevalence rates of disabled individuals worldwide will increase in the future. In several countries, special efforts have been planned and used to reduce the disparities in oral health between the disabled and the normal children. In Kuwait, disabled children have not received special attention previously. However, during the recent years special efforts have been made to cater the oral health needs of these children.

3. AIMS OF THE STUDY

The aims of this study were:

1. to determine caries experience, prevalence and treatment need, levels of oral hygiene and periodontal health, prevalence of malocclusion and traumatized anterior teeth and dental fluorosis in disabled subjects attending special needs schools (*I, II, III, IV*)
2. to determine the incidence and increment of caries in subjects with Down syndrome (*V*)
3. to examine if oral hygiene can be improved in a group of subjects with Down syndrome by supervised toothbrushing and programme of oral health education (*VI*)

4. SUBJECTS AND METHODS

Study population

Papers I-IV

Disabled children and young adults were defined, as those attending special needs schools. In Kuwait in 1999 there were 900 subjects attending 10 special needs schools. This study was carried out in Hawally, one of the six governorates of Kuwait, in the district where all the schools for the disabled are situated. The target population included all the physically handicapped, sensory disabled and Down syndrome subjects (n = 900) studying in the special needs schools in the Hawally governorate. The survey sample comprised 832 (92.4%) subjects (I, II, IV) and 818 subjects (III) from the 10 schools. The population ranged from 3 to 29 years of age (mean age = 12.1 years) (I, II, IV) and 3-20 years (mean age = 11.9 years) (III) and had a variety of disability conditions.

The schools included subjects with: a) sensory deficits – visual and hearing impairments (n = 377), b) physical handicaps - cerebral palsy, rheumatoid arthritis, congenital deformities, poliomyelitis, spinabifida, progressive muscular dystrophies, osteogenesis imperfecta, meningomyelocele, scoliosis and traumatic quadriplegia (n = 271), and c) developmental disorders – Down syndrome (n = 184). Informed consent of parents or guardians and school authorities was obtained before the subjects were included in the study. The subjects were classified according to their main reason for disability, and no other disability conditions were recorded. Prior to the dental examination, demographic information was registered for each subject: date of birth, age, school, gender, nationality (Kuwaiti, non-Kuwaiti) and residence. Kuwaitis made up 75.4% and non-Kuwaitis 24.6% of the sample, while females comprised 46.9% and males 53.1%. The distribution of the study population by disability condition and age is shown in Table 1 (I - IV). The number of individuals in the study population according to the age and gender is shown in Table 1.

Table 1. The study population according to age and gender.

<i>Age (years)</i>	<i>Sex</i>		<i>Total</i>
	<i>Male</i>	<i>Female</i>	
3	1	2	3
4	9	12	21
5	6	17	23
6	19	22	41
7	24	18	42
8	37	21	58
9	31	30	61
10	45	28	73
11	28	31	59
12	39	27	66
13	42	29	71
14	31	25	56
15	27	23	50
16	35	29	64
17	27	33	60
18	22	16	38
19	7	9	16
20	8	8	16
21	2	5	7
22	-	3	3
23	-	2	2
25	1	-	1
29	1	-	1
Total	442	390	832

Paper V

The study was conducted in boys and girls schools for children and young people with Down syndrome (n=2) in Kuwait in 2001. The target population included all subjects with Down syndrome who had permanent dentition (n=102) and moderate mental retardation and were attending these special needs schools (9-19 years old; mean age=12.6 years) in 1999 and (11-21 years old; mean age=14.9 years) in 2001. Only the same children who had been examined in 1999 were re-examined in 2001. Kuwaitis made up 85.3% and non-Kuwaitis 14.7%, while girls made up 60.8% and boys 39.2%. The distribution of the study population according to age and gender in 2001 is shown in Table 1 (V).

Paper VI

This toothbrushing intervention study was carried out in the Down syndrome boys and girls schools (n = 2) in Kuwait in 2001. Altogether 112 Down syndrome subjects ranging in age from 11 to 22 years (mean age = 14.9) participated in this intervention programme. Kuwaitis made up 84.8% and non-Kuwaitis 15.2%, while girls made up 59.8% and boys 40.2%.

Clinical data

Papers I-IV

Two calibrated, experienced dentists conducted all of the examinations together with assistants trained in survey methods. The principal examiner (MS) examined about two thirds of all children and the other examiner one third of the children. Initial training and calibration of the examiners was followed by a pilot study to finalise the diagnostic criteria. Examiners and assistants were calibrated and standardized through a series of training exercises. This procedure also included a theoretical overview, discussing issues and questions that might be encountered during the examination period. During the examinations, every 10th child was re-examined independently by each examiner to assess intra- and inter- examiner variation and to verify the results obtained in the initial exam. Altogether 83 children were examined twice (once by both examiners).

Clinical examinations were carried out at the schools, in a school medical room or classroom with natural light. Subjects who were absent at the time of the first examination were seen at a later date. Subjects were placed lying down supine on a desk or an examination couch. Those suffering from severe physical handicap and confined to a wheelchair were examined in their wheelchair. The desk or couch was placed in front of a well-lighted window, but not in direct sunlight, with the subject facing the window. No artificial dental illumination was used. The examinations were carried out with the aid of an ordinary mouth mirror and a WHO ball- tip probe. Information was recorded according to the criteria described by WHO (WHO, 1997b). The data for each subject were recorded on the standard WHO oral health survey form that has been modified for recording the data (Appendix 4). To ensure accuracy, each form was checked at the end of the day by the examiner.

Paper V

Two examiners (MS, EH) examined the subjects. The principal examiner (MS) examined two thirds and the other examiner (EH) one third of the children. On all erupted teeth dental caries was scored by surface in accordance with the WHO criteria (WHO, 1997b). No radiographs were used to detect caries.

Paper VI

Two examiners (MS, EH) examined the subjects. The principal examiner (MS) examined two thirds and the other examiner (EH) one third of the children. Baseline plaque was scored according to the Sillness & Loe PII (1964), and gingivitis was scored according to the Loe & Sillness GI (1963) (Appendix 5). Supervised toothbrushing (individual and group) sessions were conducted in the classrooms twice a week after breakfast and the subjects were taught by two well-trained dental hygienists how to brush their teeth. Individual instruction and assistance in brushing and demonstrations on toothbrushing technique were arranged for both the subjects and the teachers, who supervised the brushing when the dental hygienists were not at the school. Brushing took place once a day at school. Some subjects had no previous experience of toothbrushing. The dental team visited the school twice a week, offering encouragement and support to the staff, and where necessary, demonstrating techniques, for children with special difficulties. The dental team and the teachers helped the subjects to brush their teeth, or supervised their brushing, and depending on their ability, showed them how to improve their technique. Subjects were taught to brush their own teeth; those with difficulties had their teeth cleaned by the dental staff or the teachers. The subjects were even taught other skills such as how to put paste onto the brush. No professional methods of prophylaxis were used during the intervention period. At the end of 3 months, the programme was evaluated and the subjects were re-examined for clinical scoring. Because the clinical examinations were arranged during several days all children who were examined at the beginning were also examined at the end of the study.

Dental Status

Dental caries (I)

Caries experience was determined using the decayed, missing and filled surfaces index on all erupted teeth according to criteria defined by the WHO (WHO, 1997b). Dental caries was scored by surface on all erupted teeth in accordance with the WHO criteria (WHO, 1997b). Radiographs were not used for caries detection (I). A numerical coding system was used for recording the status of permanent teeth, and an alphabetical coding system was used for the primary teeth. The coding system for dental status was as follows:

Permanent tooth code	Condition/status	Primary tooth code
0	Sound	A
1	Decayed	B
2	Filled, with decay	C
3	Filled, no decay	D
4	Missing, as a result of caries	E
5	Missing, for any other reason	—
6	Fissure sealant	F
7	Bridge abutment or special crown	G
8	Unerupted tooth	—
9	Excluded	—
T	Trauma (fracture)	T

All questionable lesions were recorded as sound. The presence of dental caries was recorded if caries was observed at the cavitation level (detectable softened floor, undermined enamel or softened wall). This level of diagnosis was used to ensure standardisation of the diagnosis and to allow comparison with other epidemiological studies using this standard. A tooth was considered filled with decay, when it had one or more permanent restorations and one or more areas that were decayed. A tooth was considered filled without decay when one or more restorations were present and there was no caries anywhere on the crown; a tooth was considered missing if it had been extracted because of caries. Excluded tooth, code 9, was used when the tooth could not be examined. Sealants were detected by the visual-tactile method in accordance with the criteria of WHO (WHO, 1997b) (I). The caries levels were categorized according to WHO classifications (WHO, 1980b) as very low (≤ 1.1), low ($1.2 - 2.6$), moderate ($2.7 - 4.4$), high ($4.5 - 6.5$) or very high (≥ 6.6).

In the incidence study (V), the incidence percentage was calculated as the percentage of new subjects who got caries in the 2 - year period (1999-2001). These subjects had no caries lesion at baseline (1999), but had at least one lesion in the second examination (2001). Incidence percentages were also calculated separately according to the different teeth.

Oral hygiene status (II)

Oral hygiene status was recorded using the special plaque index (James et al., 1960) by visually evaluating the presence of plaque on the buccal and lingual surface of upper and lower incisors and canines. Teeth were classified as “good”, if no plaque was visible, “fair”, if there was a small quantity of plaque or recent food accumulation, and “poor”, if there was considerable plaque or long-standing accumulation of food.

Oral hygiene habits (II)

Oral hygiene habits were recorded as: toothbrushing frequency and provision of help with toothbrushing (II). Oral hygiene habits consisted of toothbrushing frequency (0 = none/ < once a day; 1 = once/day, 2 = > once/day) and provision of help with toothbrushing (0 = none, child brushes completely independently, 1 = moderate, child receives some help with brushing; 2 = extensive, parents or caregivers brush child's teeth).

Periodontal condition and treatment needs (II)

The community periodontal index of treatment needs (CPITN) was selected for assessment of periodontal condition and needs (WHO, 1997b). The highest reading in a sextant was recorded.

- (a) Three indicators of periodontal status were used for the assessment: 1) presence or absence of gingival bleeding, 2) supra-and sub-gingival calculus, 3) periodontal pockets-subdivided into 4-5 mm and ≥ 6 mm (Ainamo et al., 1987)
- (b) The dentition was divided into six sextants (one anterior and two posterior tooth regions in either arch) defined by teeth numbers 17-14, 13-23, 24-27, 37-34, 33-43, and 44-47. A sextant was examined only if there were two or more teeth present and these were not indicated for extraction. When only one tooth remained in the sextant, it was included in the adjacent sextant.

- (c) As the majority of the subjects were under the age of 20 years, only six index teeth - 16, 11, 26, 36, 31 and 46 - were examined. This modification was made in order to avoid scoring the deepened sulci associated with eruption as periodontal pockets. When children under the age of 15 were examined, pockets were not recorded; only bleeding and calculus were considered.
- (d) The index tooth, or all remaining teeth in a sextant where there is no index tooth, was to be probed and the highest score recorded.

The codes (sextant scores) were:

- 0 - Healthy,
- 1 - Bleeding observed, directly or using a mouth mirror, after probing,
- 2 - Calculus detected during probing,
- 3 - Pocket 4-5 mm, (gingival margin within the black band on the probe),
- 4 - Pocket 6 mm or more, (black band on the probe not visible),
- X - Excluded sextant (less than two teeth present),
- 9 - Not recorded.

Since only the worst finding is recorded, the CPITN is based on an assumed hierarchical relationship between these indicators.

Treatment needs (TN) of groups or individuals were determined from the highest CPITN sextant scores within individuals and in common with the clinical scoring scheme. Treatment need was designed with a hierarchical structure as follows:

TN 0: A recording of Code 0 (healthy) or X (missing) for all six sextants indicates that there is no need for treatment.

TN 1: Improvement in personal oral hygiene is indicated (Code 1).

TN 2: A Code of 2 or higher indicates a need for professional cleaning of the teeth and removal of plaque and retentive factors. In addition, the patient requires instruction in oral hygiene.

TN 3: A sextant scoring of Code 4 is assigned as “complex treatment”, which can involve deep scaling and more complex surgical procedures.

Malocclusions (III)

Malocclusion was identified in accordance with WHO criteria (WHO, 1987) (III) and was recorded as: no malocclusion 0, slight malocclusion 1, and severe malocclusion 2. Two levels of anomaly were registered: slight malocclusion - such as one or more rotated or twisted teeth, crowding or spacing and severe malocclusion - anomalies that cause an unacceptable effect on facial appearance, significant reduction in masticatory function, impairment of speech, or one or more of the following conditions of the four anterior incisors: maxillary overjet ≥ 9 mm, mandibular overjet \geq one full tooth depth, open bite, midline shift ≥ 4 mm, crowding or spacing ≥ 4 mm.

Traumatic injuries (III)

All tooth surfaces with a fracture of the crown were given the score T (WHO, 1997b) (III). To receive this score, tooth surface should be missing as a result of trauma and there should be no evidence of caries.

Dental fluorosis (IV)

Dental fluorosis was scored according to Dean's classification (WHO, 1997b) (IV), and dental fluorosis status was determined using Dean's dental fluorosis index (WHO, 1997b). The recording was made on the basis of the two most affected teeth. If the two teeth were not equally affected, the score for the less affected of the two was recorded. The teeth were not especially cleaned or dried.

The codes and criteria were:

- 0 - Normal: the enamel surface is smooth, glossy and usually a pale creamy-white colour,
- 1 - Questionable: the enamel shows slight aberrations from the translucency of normal enamel, which may range from a few white flecks to occasional spots. This classification is used where the classification "normal" is not justified,
- 2 - Very mild: small, opaque, paper-white areas scattered irregularly over the tooth but involving less than 25% of the labial surface,

- 3 - Mild: the white opacity of the enamel of the teeth is more extensive than for code 2, but covers less than 50% of the tooth surface,
- 4 - Moderate: the enamel surfaces of the teeth show marked wear and brown stain is frequently a disfiguring feature,
- 5 - Severe: the enamel surface is badly affected and hypoplasia is so marked that the general form of the tooth may be affected. There are pitted or worn areas and brown stains are widespread; the teeth often have a corroded appearance.

Plaque and Gingival scoring (VI)

Separate recordings of PII and GI indices were made for the 4 smooth surfaces of each tooth. Every tooth surface was evaluated and each of the buccal, mesial, lingual and distal surfaces was given a score of 0-3. The whole-mouth mean scores were calculated from all scorable tooth surfaces in the mouth. No disclosing solution was used.

Baseline plaque was scored according to the Silness & Loe plaque index (Silness & Loe, 1964). The plaque thickness at the gingival margin was assessed.

The criteria for scoring were:

- 0 - No plaque in the gingival area.
- 1 - A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may only be recognized by running a probe across the tooth surface, not visible by the naked eye.
- 2 - Moderate accumulation of soft deposits within the gingival pocket, on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye.
- 3 - Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.

Gingivitis was scored according to the Löe & Silness gingival index (Löe & Silness, 1963). The GI consists of four grades, which are judged according to inflammation, colour change and bleeding at each tooth surface.

The criteria for scoring were:

0 - Normal gingiva.

1 - Mild inflammation – slight change in colour, slight edema, no bleeding on probing.

2 - Moderate inflammation – redness, edema and glazing, bleeding on probing.

3 - Severe inflammation – marked redness and edema, ulceration, tendency toward spontaneous bleeding.

Statistical methods

Data were analysed using the statistical software SPSS, Windows versions 9.0 and 10.0.

In descriptive statistics the mean, median, and standard deviation were used to describe the patterns of oral health, which were calculated for all groups. Age was standardized when the groups were compared. Age was not a strong confounding factor as the mean age was almost the same, except among the hearing impaired who were 2 years older than the other three groups. In caries indices, age was controlled by direct standardization.

Chi-square tests were used to test differences in frequencies between groups and for testing associations between the background factors (age groups, gender, nationality, disabling condition) with caries experience (I), prevalence of periodontal disease (II), malocclusion & traumatic injuries (III) and dental fluorosis (IV). Fisher's exact test was used to test the association of differences between the caries-free proportions at baseline and those at the final examinations (V). Wilcoxon signed-rank test was used to test the differences of the caries increment (V). One-way Analysis of Variance (ANOVA) was used to test the differences in the mean scores of caries increment between the age groups (V). The Mann-Whitney test was used to test differences in the gender and nationality with caries experience (I, V). The Kruskal Wallis test was used to test differences between disability groups with caries experience (I) and to compare the mean number of sextants affected with periodontal disease between the disability groups (II).

Multivariate analysis (logistic regression) was used to test the associations of various socio-demographic and other factors with the occurrence of disease (I, II, III, IV). The odds ratios (OR) with 95% confidence intervals (95% CI) were used to estimate the relative risk of the studied background factors for the occurrence of various dental diseases. Only those subjects aged 15 or more years were included in the multivariate analysis for occurrence of periodontal disease (II); and predictive power was determined and the overall goodness of fit of the final model was checked with the Hosmer and Lemeshow Goodness-of-Fit test (II).

Paired- Samples T- test was used to test differences in the mean plaque and gingival scores at the baseline and in the final examinations (VI). The independent-Samples t-test was used to test the differences between gender (boys and girls) and nationalities (Kuwaiti, non-Kuwaiti) (VI). One-Way Analysis of Variance (ANOVA) was used to test the differences in the mean scores between the age groups (VI). Bivariate Correlations were used to measure the relationships between mean plaque and gingival scores at baseline and in the final assessments. Pearson's Correlation Coefficient (r) was used to measure the linear association between the mean plaque and gingival scores (VI).

Examiner reliability

Reproducibility of the caries diagnoses of the two examiners by kappa statistics was 0.9 (I, V). The inter-examiner reliability of the CPITN assessment between the two examiners was 80% and the intra-examiner reliability 86% (II). Intra- and inter-examiner variation was less than 5% for malocclusions and traumatic injuries (III). Intra- and inter-examiner agreement for Dean's index was 80% (IV). The inter-examiner assessments correlated highly both for plaque ($r = .96$) and gingivitis scores ($r = .94$). There was full agreement on 70% of the surfaces for plaque scores and on 80% of the surfaces for gingivitis scores (VI).

5. RESULTS

Dental caries experience (I)

Dental caries in the primary dentition

The proportion of 3- to 12-year-old children ($n = 384$) with caries-free primary dentition ($dmft = 0$) was 13.9%. The proportions of caries-free children did not differ significantly between disability groups (Table 2). The mean $dmft$ was 5.6, and mean $dmfs$ was 15.1, being highest in the Down syndrome and lowest in the blind. The differences in ds , ft , and fs components were significant. When the components of the dmf index were studied separately, 81.5% of the teeth were decayed, 9.1% were missing and 9.4% were filled. By site, 26.5% of the 4-year-olds and 28.9% of the 6-year-olds had decay in their front teeth. Occlusal caries represented 33.2% of the decay at the age of 4 years and 23.9% at the age of 6. In the primary dentition, the mean $dmft$ among different disability conditions with age was parabolic (with an initial increase and later, a decrease mostly from age 7-8 onwards) (Fig. 1).

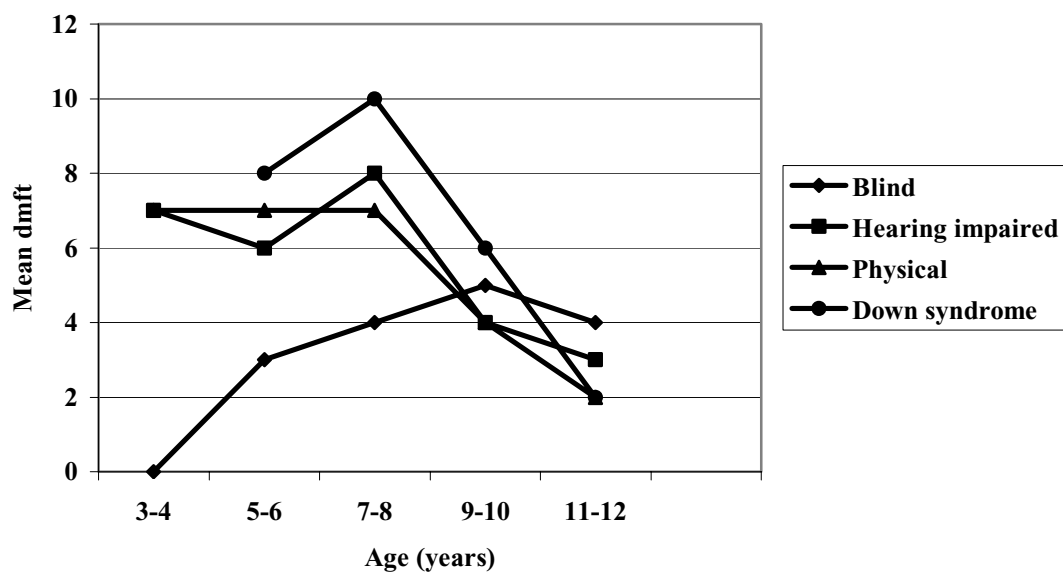


Fig.1. Mean $dmft$ according to age among different disability conditions with age.

Table 2. Proportions (%) of caries-free subjects and means of different caries indices in the primary dentition according to disability condition (age-standardized).

Caries-free%										
Group	n	dmf=0	dt	mt	ft	dmft	ds	ms	fs	dmfs
Blind	29	20.4	2.7	0.1	0.4	3.1	5.8	0.7	0.6	7.1
Hearing impaired	111	12.3	4.8	0.4	0.3	5.5	12.0	2.2	0.9	15.0
Physical	149	17.9	4.2	0.4	0.6	5.2	10.1	2.1	1.3	13.5
Down syndrome	95	7.2	5.5	0.6	0.5	6.6	14.8	3.2	1.4	19.9
Total	384	13.9	4.8	0.4	0.5	5.6	11.9	1.9	1.3	15.1
Statistical significance (p) [*]		0.604	0.061	0.359	0.001	0.150	0.006	0.359	0.001	0.030

^{*}Differences between the different disability groups.

Dental caries in the permanent dentition

The proportion of subjects over 5 years of age ($n = 774$) with caries-free permanent dentition ($DMFT = 0$) was 19.0%. The lowest percentage of caries-free subjects was found in the hearing-impaired group (18.4%) and the highest percentage in the blind (38.7%) ($p < 0.001$) (Table 3). The mean DMFT was 5.9 and the mean DMFS 13.3, being highest in subjects with Down syndrome and lowest in the blind ($p < 0.001$). The differences between the DT and DS components were significant. However, the differences between caries experience according to gender, nationality, maxillary and mandibular teeth were not statistically significant.

According to WHO classifications (WHO, 1980b), when the groups with disabilities were categorized by caries levels, 11.7% of the subjects with Down syndrome belonged to the high caries level ($DMFT = 4.5-6.5$), and 30.9% of the hearing-impaired subjects belonged to the very high caries level ($DMFT = \geq 6.6$) (Table 4).

When the age groups were categorized by caries levels, 17.5% of the subjects in the 12-13 age group belonged to the high caries level. Of the 14 - 15 year-olds 40.6% and 53.8% of the 15-year-olds and above belonged to the very high caries level (Table 5).

When the components of the DMF index were analysed, decayed teeth made up 84%, missing teeth 6.4% and filled teeth 9.6% of the dentition. Most of the caries lesions appeared on occlusal surfaces (44.5%), and on free smooth surfaces (28.0%) of the posterior teeth but less in the anterior teeth (16.7%) and on proximal surfaces of the posterior teeth (10.8%) (Table 6). The percentage of subjects with sealants was 34.2% and the mean number of sealed teeth was 1.4 (Table 4; I).

Among the different disability conditions, the mean DMFT in the permanent dentition increased constantly with age (Fig.1; I).

In the permanent dentition, when simultaneous associations of the specified explanatory variables with caries experience were studied, increasing age ($OR = 1.28$, 95% $CI = 1.26-1.37$), impaired hearing ($OR = 2.02$, 95% $CI = 1.03-3.97$) and poor oral hygiene ($OR = 2.82$, 95% $CI = 1.75-4.57$) were significantly associated with caries risk (Table 5; I). When oral hygiene was replaced by toothbrushing habits in the model, it did not reach the level of significance.

Table 3. Proportions (%) of caries-free subjects and means of different caries indices in the permanent dentition according to disability condition (age-standardized).

Caries-free%										
Group	n	DMF=0	DT	MT	FT	DMFT	DS	MS	FS	DMFS
Blind	62	38.7	2.1	0.3	0.4	2.8	3.5	1.4	0.5	5.4
Hearing impaired	304	18.4	4.5	0.3	0.3	5.1	7.4	1.5	0.6	9.5
Physical	229	24.8	3.7	0.5	0.7	4.9	8.4	2.4	1.1	11.6
Down syndrome	179	21.4	5.7	0.6	0.5	6.9	11.3	2.8	0.9	15.0
Total	774	19.0	4.8	0.5	0.6	5.9	9.9	2.5	0.9	13.3
Statistical significance (p) [*]		<0.001	<0.001	0.134	0.309	<0.001	<0.001	0.125	0.278	<0.001

^{*}Differences between the different disability groups.

Table 4. Percentage distribution of the mean DMFT by caries levels according to disability condition.

<i>Group</i>	<i>n</i>	<i>Level of caries</i>					
		<i>Caries free</i>	<i>Very low</i> (<i>< 1.1</i>)	<i>Low</i> (<i>1.2-2.6</i>)	<i>Moderate</i> (<i>2.7-4.4</i>)	<i>High</i> (<i>4.5-6.5</i>)	<i>Very high</i> (<i>≥ 6.6</i>)
Blind	62	35.5	6.5	3.2	35.5	8.1	11.3
Hearing impaired	304	16.4	7.9	10.2	24.3	10.2	30.9
Physical	229	32.3	8.7	10.9	20.5	9.2	18.3
Down syndrome	179	22.9	5.0	8.9	20.7	11.7	30.7
Total	774	24.2	7.4	9.6	23.3	10.1	25.6

Table 5. Percentage distribution of the mean DMFT by caries levels according to age groups.

<i>Age</i>	<i>n</i>	<i>Level of caries</i>					
		<i>Caries free</i>	<i>Very low</i> (<i>< 1.1</i>)	<i>Low</i> (<i>1.2-2.6</i>)	<i>Moderate</i> (<i>2.7-4.4</i>)	<i>High</i> (<i>4.5-6.5</i>)	<i>Very high</i> (<i>≥ 6.6</i>)
6-7	72	69.4	13.9	5.6	11.1	0.0	0.0
8-9	119	43.7	11.8	13.4	29.4	0.8	0.8
10-11	132	26.5	4.5	18.9	34.8	9.8	5.3
12-13	137	18.2	6.6	8.8	23.4	17.5	25.5
14-15	106	4.7	7.5	6.6	29.2	11.3	40.6
16-17	124	10.5	6.5	4.0	14.5	12.9	51.6
>17	84	8.3	2.4	6.0	11.9	14.3	57.1
Total	774	24.2	7.4	9.6	23.3	10.1	25.6

Table 6. Occurrence (%) of caries on different surfaces of the permanent teeth.

<i>Age groups</i>	<i>Posterior teeth</i>			<i>Front teeth</i>
	<i>Occlusal</i> <i>[O]</i>	<i>Proximal</i> <i>[M, D]</i>	<i>Smooth</i> <i>[B, L]</i>	<i>[Smooth + proximal]</i>
6 – 8	55.4	6.8	37.9	0.0
9 – 11	44.4	9.3	35.0	11.3
12 – 14	45.3	9.8	28.3	16.6
≥ 15	43.5	11.9	25.4	19.2
Total	44.5	10.8	28.0	16.7

When these associations were combined with caries experience in the different disability conditions, in all disability conditions increasing age was significantly associated with caries risk ($p = 0.00$). Poor oral hygiene was significantly associated with caries risk in subjects with impaired hearing ($p = 0.01$), physical handicap ($p = 0.04$) and Down syndrome ($p = 0.01$). In Down syndrome subjects the presence of sealants was significantly associated with lower caries risk ($p = 0.00$) (Table 7).

Table 7. Estimated Relative risks (odds ratios based on logistic regression model), their confidence intervals and p-values for caries prevalence in the disability conditions according to various factors.

	<i>Blind</i>			<i>Hearing impaired</i>			<i>Physical</i>			<i>Down syndrome</i>		
	<i>OR</i>	<i>95% CI</i>	<i>p</i>	<i>OR</i>	<i>95% CI</i>	<i>p</i>	<i>OR</i>	<i>95% CI</i>	<i>p</i>	<i>OR</i>	<i>95% CI</i>	<i>p</i>
Sex												
Male (ref.)	1.00			1.00			1.00			1.00		
Female	1.49	0.37 - 6.0	0.58	1.21	0.60 - 2.42	0.59	0.65	0.34 - 1.23	0.19	0.49	0.20 - 1.23	0.13
Nationality												
Kuwaiti (ref.)	1.00			1.00			1.00			1.00		
Non-Kuwaiti	1.91	0.37 - 9.76	0.44	0.99	0.50 - 1.99	0.98	0.78	0.32 - 1.92	0.58	0.89	0.28 - 2.89	0.85
Oral hygiene												
Fair and good (ref.)	1.00			1.00			1.00			1.00		
Poor	1.86	0.28 - 12.43	0.52	3.59	1.31 - 9.85	0.01	2.15	1.00 - 4.63	0.04	4.50	1.51 - 13.43	0.01
Sealants												
None (ref.)	1.00			1.00			1.00			1.00		
Sealants	0.23	0.04 - 1.34	0.10	0.79	0.40 - 1.53	0.48	1.10	0.55 - 2.22	0.78	0.22	0.08 - 0.60	0.00
Age	1.84	1.26 - 2.68	0.00	1.25	1.13 - 1.38	0.00	1.24	1.12 - 1.36	0.00	1.42	1.19 - 1.70	0.00

Oral hygiene and periodontal conditions (II)

Oral hygiene habits

Of all the subjects studied, 87% brushed their teeth daily. The highest proportion of children brushing more than once a day was among blind children (74%) and the lowest among physically disabled children (50%) ($p < 0.001$) (Fig. 2). Females brushed more frequently than males did ($p < 0.001$). Blind females brushed most frequently (90% brushed more than once a day) and the physically disabled females least frequently (54%).

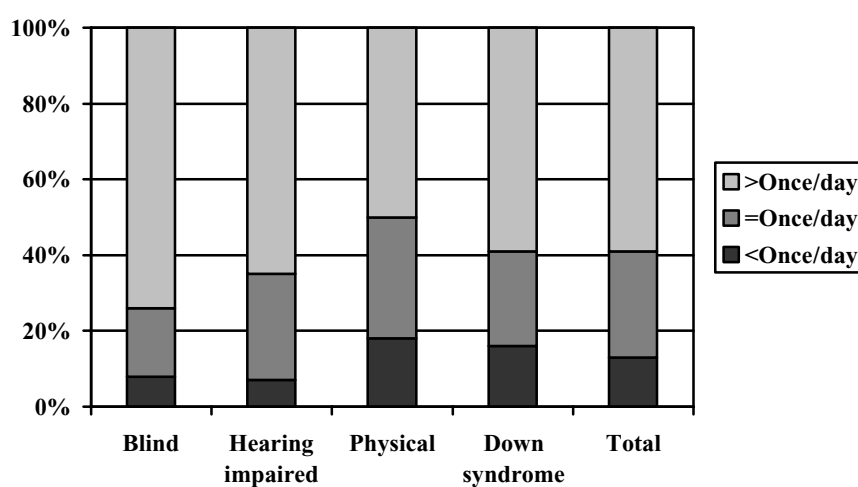


Fig. 2. Toothbrushing frequency (%) according to disability condition.

Of the subjects who brushed their teeth, 72% had no help with toothbrushing, 11% received some help, 17% were extensively helped by their parents or caregivers (Fig. 3). Subjects with hearing-impairment most rarely had help from their parents (10%; ($p < 0.001$)) (Fig. 3). In the physically disabled group, 31% of the subjects had their teeth brushed extensively by their parents or carers. Subjects in the group with Down syndrome had more help with toothbrushing (50%) than did those in the other groups (10 - 39%).

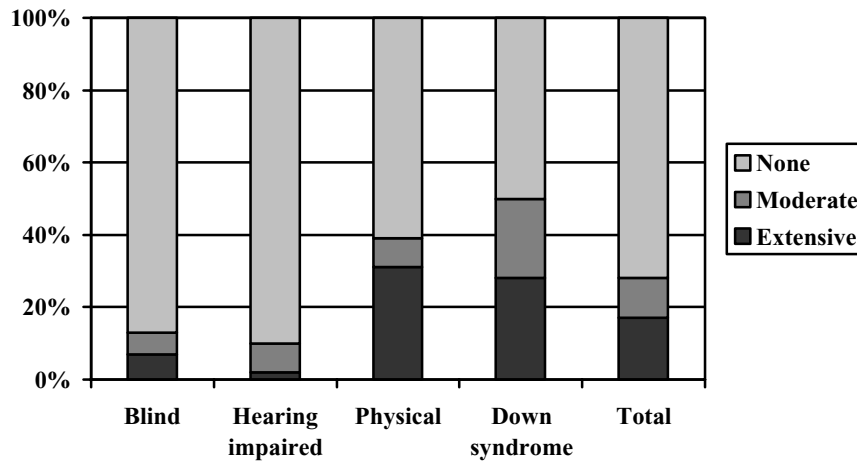


Fig. 3. Provision of help with toothbrushing (%) according to disability condition.

Oral hygiene status

The evaluation of oral cleanliness showed poor hygiene in 38% of the subjects (Fig. 4). Significant differences in oral cleanliness were found among types of disability conditions. The proportion of subjects with good oral hygiene was highest among the blind (26%) and lowest among subjects with Down syndrome (8%; $p < 0.001$). Conversely, the proportion of children with poor oral hygiene was lowest among the blind (31%) and highest among those with Down syndrome (52%; $p < 0.001$). There was no difference between males and females; however, a significant association between toothbrushing frequency and oral hygiene score was observed both in males ($p < 0.001$) and in females ($p < 0.05$).

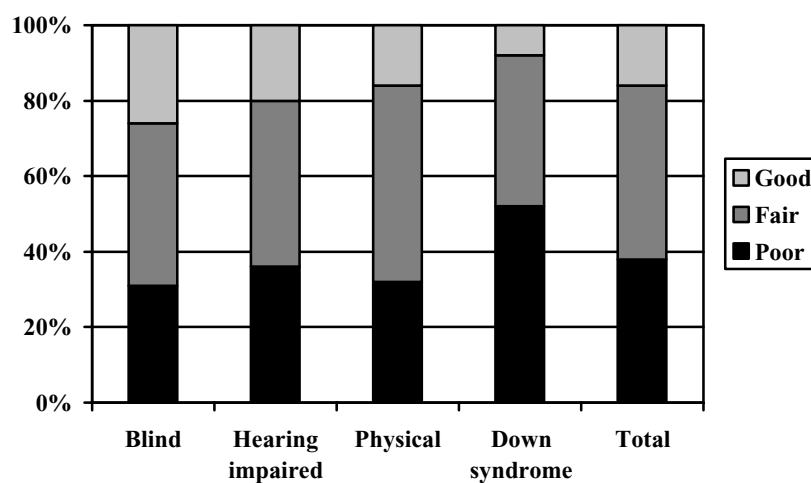


Fig. 4. Oral hygiene status (%) according to disability condition.

Periodontal status

Results of the assessment of periodontal disease by the Community Periodontal Index of Treatment Needs are shown in (Tables 3 & 4; II). The proportion of subjects with a healthy periodontium was only 10% among subjects 15 years and over (Table 3; II). As 50% of the subjects had calculus, the proportion of subjects with calculus was very high. Shallow pockets were present in 24% and deep pockets in 5% of the subjects aged 15 years and over (Table 3; II). The subjects with Down syndrome had the highest proportion of pockets, 60%; one-third of them had deep pockets. The hearing-impaired group had the lowest proportion of pockets, 21% ($p < 0.001$).

The highest mean number of sextants with pockets (shallow + deep) was observed among subjects with Down syndrome (2.0) and the lowest among the hearing-impaired (0.6) ($p < 0.001$) (Table 4; II). The mean number of sextants with bleeding or higher scores was 2.0 among the subjects under 15 years of age and 3.9 among those 15 years and over in the whole study population (Table 8).

When the simultaneous associations of different explaining variables were studied by the logistic regression model for the occurrence of periodontal disease (prevalence of shallow and deep pockets) in the subjects aged 15 years and above, oral hygiene seemed to be the highest risk factor (OR = 8.5; 95% CI = 3.5-20.9), and Down syndrome the second highest (OR = 3.6; 95% CI = 1.8-7.3) (Table 9).

Periodontal treatment needs

The need for complex periodontal treatment was highest in subjects with Down syndrome (21%) (Table 5; II).

Table 8. Mean number of sextants in the sample coded by CPITN (0-4) according to disability condition.

<i>Group</i>	<i>Age</i>	<i>N</i>	<i>Healthy</i>	<i>Bleeding or higher score</i>	<i>Calculus or higher score</i>	<i>Shallow pockets *P or higher score</i>	<i>Deep pockets P</i>	<i>Excluded (less) than (2 teeth)</i>
Blind	<15	55	4.0	2.0	1.2	-	-	0.02
	≥15	10	1.6	4.4	3.2	0.9	0.0	0.0
Hearing impaired	<15	184	3.9	2.1	1.2	-	-	0.0
	≥15	128	2.7	3.3	2.5	0.5	0.1	0.0
Physical	<15	199	4.2	1.7	1.0	-	-	0.03
	≥15	72	1.4	4.6	3.0	0.8	0.01	0.0
Down syndrome	<15	136	3.9	2.0	1.3	-	-	0.05
	≥15	48	1.5	4.5	3.4	1.9	0.4	0.0
All	<15	574	4.0	2.0	1.1	-	-	0.02
	≥15	258	2.1	3.9	2.8	0.9	0.1	0.0
Total	3-29	832	3.4	2.6	1.7	0.3	0.03	0.04

P* Pockets not recorded for children under 15 years of age.

Table 9. Estimated relative risks (odds ratios based on the logistic regression model), their 95% confidence intervals and p-values for prevalence of periodontal disease according to various factors among individuals 15 years and older.

	<i>OR</i>	<i>95% CI</i>	<i>Statistical significance (p)</i>
Disability condition			
Blind, hearing impaired and physical (ref.)	1.00	-	
Down syndrome	3.60	1.80 – 7.30	0.00
Sex			
Male (ref.)	1.00		
Female	1.15	0.60 – 2.20	0.67
Oral hygiene			
Fair and good (ref.)	1.00	-	
Poor	8.50	3.50 – 20.90	0.00
Nationality			
Non-Kuwaiti (ref.)	1.00	-	
Kuwaiti	1.02	0.51 – 2.01	0.96
Toothbrushing frequency			
> Once/day (ref.)	1.00	-	
< Once/day and once/day	1.15	0.60 – 2.20	0.67

Malocclusion and traumatic injuries (III)

Malocclusions

Prevalence of severe malocclusion was 23.6% and that of slight malocclusion 37.2% (Fig. 5). Significant differences were found between groups. This proportion of malocclusion was highest in subjects with Down syndrome, where 36.6% had severe malocclusion and lowest in the blind, 7.7% ($p < 0.001$). The respective proportion in hearing-impaired subjects was 21.8% and in the physically disabled, 20.6%. In multivariate analysis, subjects with Down syndrome (OR = 2.3; 95% CI = 1.51-3.52), increasing age (OR = 1.1; 95% CI = 1.01-1.10) and males (OR = 1.5; 95% CI = 1.05-2.07) had higher risk for occurrence of severe malocclusion than the other groups (Table 3; III).

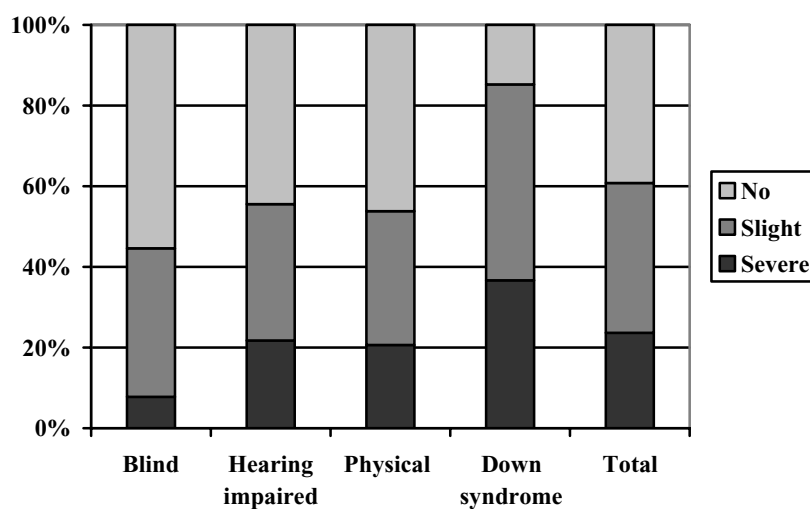


Fig. 5. Severity of malocclusion (%) according to disability condition.

Traumatic injuries

Less than one-fifth of the subjects (16.9%) had traumatized anterior teeth. One-fourth of the subjects (24.6%) in the blind group had traumatic injuries compared with 19.8% of the hearing-impaired and 13.7% of those with physical disabilities and Down syndrome ($p = 0.049$) (Table 4; III). Gender and nationality were not associated with the occurrence of traumatic injuries. Experience of traumatic injuries was less common among young children, and those under 6 years of age had no injuries. Only about 10% of the 6 - 12 year-olds had injuries, but injuries were found in 27.5% of adolescents over 13 years old (Table 4; III).

In multivariate analysis, gender and nationality were not significant risk factors for trauma. Significant risk factors for occurrence of traumatic injuries were severe malocclusion (OR = 1.8; 95% CI=1.17-2.77) and increasing age (OR = 1.2; 95% CI = 1.13-1.26) (Table 5; III).

Dental fluorosis (IV)

None of the subjects had severe fluorosis; 0.2% of them showed moderate fluorosis; 0.8% had mild fluorosis; 2.4% had very mild fluorosis and 6.1% had questionable fluorosis (Table 2; IV). Up to the age of 7 years there were no subjects with fluorosis, but among those between 8 and 20 years the prevalence varied from 0 to 10% (Fig. 1; IV); and only one subject above 20 years of age had fluorosis. According to bivariate analysis fluorosis and age were not associated ($p = 0.094$), but non-Kuwaitis had higher prevalence of fluorosis (6.8%) than Kuwaitis (2.4%; $p = 0.004$, OR = 3.0). The prevalence of dental fluorosis did not differ among the disabling conditions ($p = 0.275$) or between the gender ($p = 0.513$). When the simultaneous associations of different explanatory variables were studied using a logistic regression model for the occurrence of fluorosis, Non-Kuwaiti nationality was a significant risk factor for dental fluorosis (OR = 2.4; $p = 0.027$) (Table 3; IV).

Incidence of dental caries (V)

The caries incidence among Down syndrome subjects was 10.3%, while the proportion of caries-free subjects (DMFS = 0) decreased from 17.6% in 1999 to 7.3% in 2001 ($p < 0.05$). During the same period the caries increment (DMFT) was 3.0. The mean DMFS increased from 10.2 to 16.5, indicating an increment of 6.3 caries-affected surfaces during this 2-year period ($p < 0.001$). Caries increment (number of teeth with new caries) was highest among 17-year-olds and older; but caries increment, as measured by the number of new caries surfaces, was highest in 11-year-olds ($p > 0.05$) (Fig. 1; V). Caries increment was lowest among 12 – 13 year-olds, and highest in 14-15-year-olds (DMFT) and in older than 17 year-olds (DMFS) ($p > 0.05$) (V; Fig. 2). For individual teeth the caries incidence was highest in the lower second molars (22.1%) and the upper first molars (17.7%) (Fig. 3; V).

Supervised toothbrushing programme (VI)

Among the subjects with Down syndrome the plaque and gingivitis scores decreased significantly during the 3-month period ($p < 0.001$). The mean plaque score decreased from 1.93 (SD = 0.43) to 0.95 (0.53; $p < 0.001$), and the mean gingival score from 2.00 (0.47) to 0.83 (0.56; $p < 0.001$) (Figs. 6 & 7). The reduction of plaque and gingivitis scores was significant in all age groups ($p < 0.001$) and for both gender (Tables 2 & 3; VI). The mean gingivitis score at the baseline was higher in boys (2.10) than in girls (1.94; $p = 0.007$), but the final mean gingivitis score was higher in girls (0.85) than in boys (0.82; $p = 0.008$) (Table 3; VI).

The mean reduction of the plaque and gingival indices differed only slightly between groups of teeth (Fig. 1 & 2; VI).

Positive correlation between PII and GI was quite high. There was high correlation between the individual plaque and gingivitis scores at the baseline examinations ($r = 0.83$) and between the plaque and gingivitis scores at the final examinations ($r = 0.91$) (Fig. 8). The correlation between the baseline plaque score and the final plaque score was 0.74 and the correlation between the baseline gingivitis and the final gingivitis score was 0.73. The correlation between the reduction in plaque and the reduction in gingivitis was 0.69.

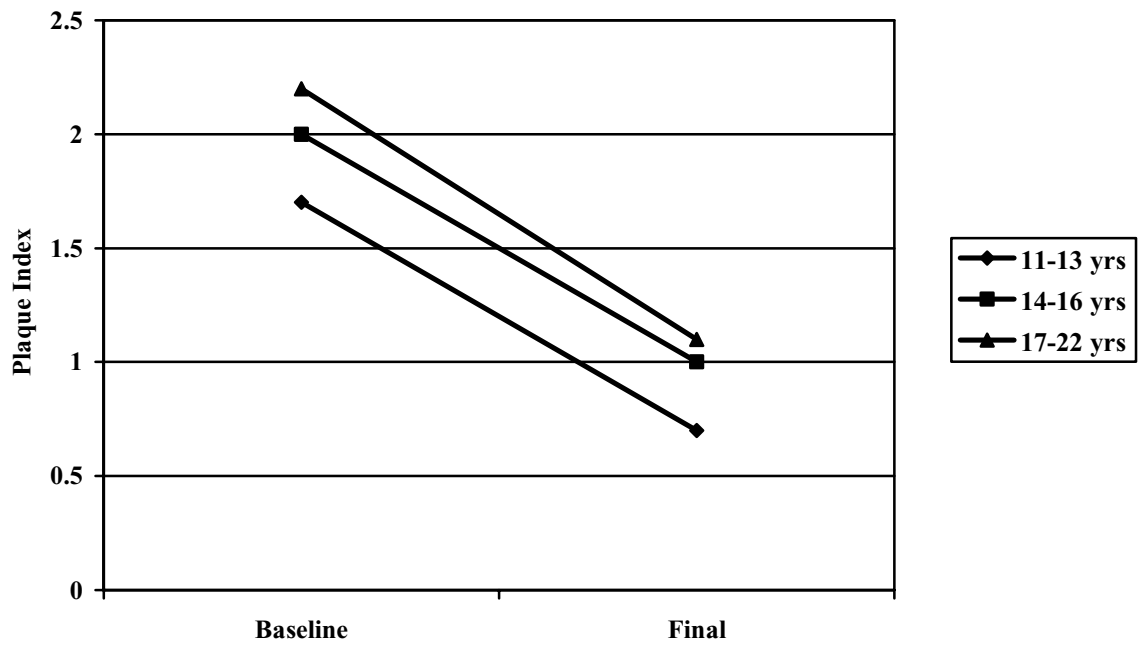


Fig. 6. Mean Plaque Index by age groups at baseline and in the final examinations.

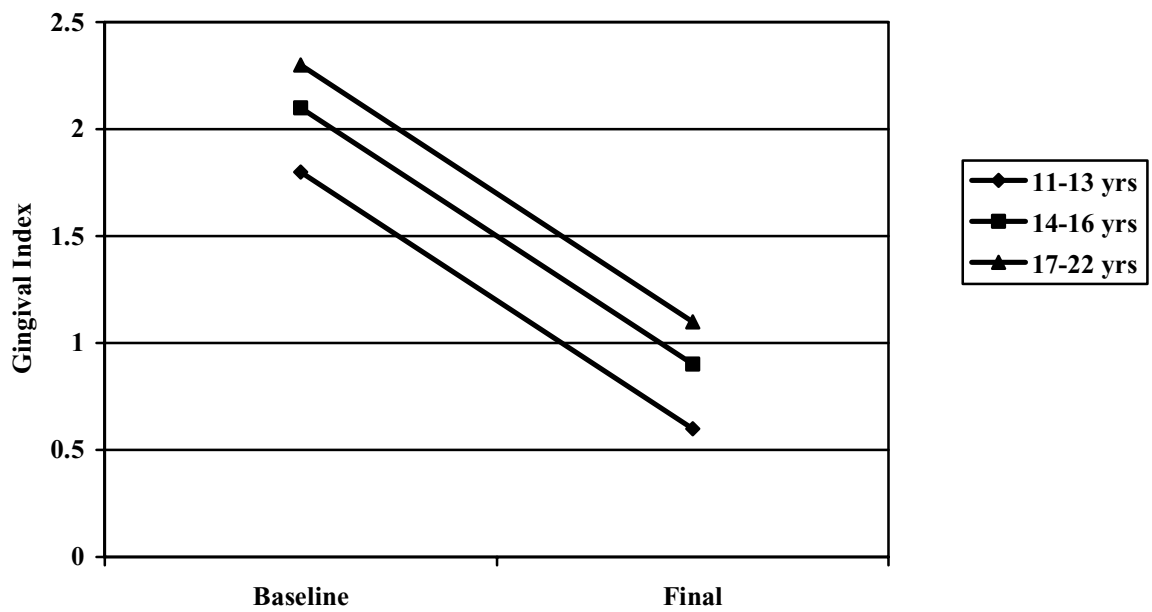


Fig. 7. Mean Gingival Index by age groups at baseline and in the final examinations.

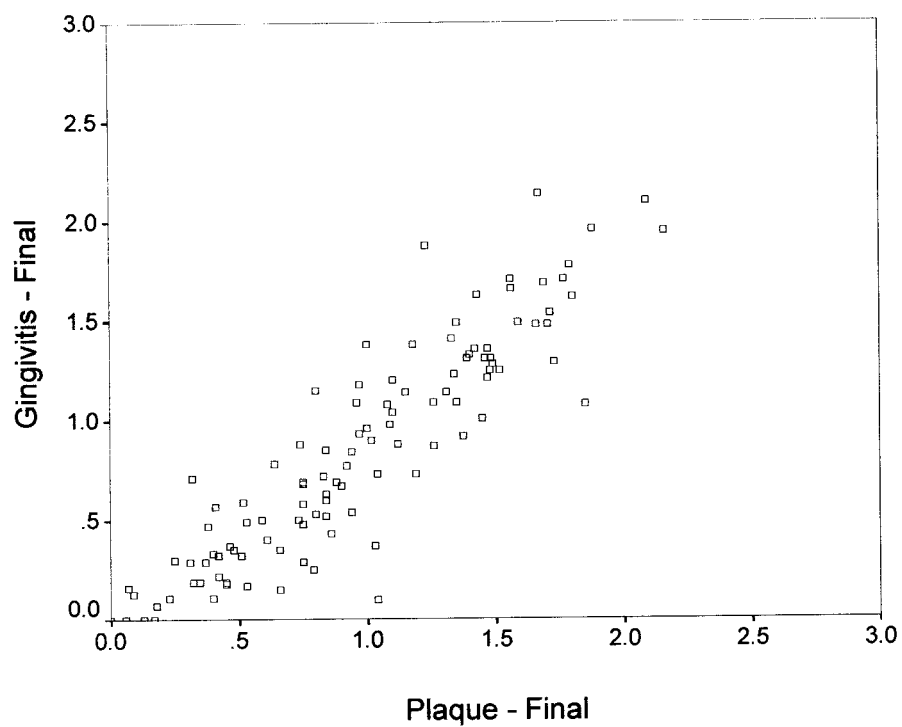
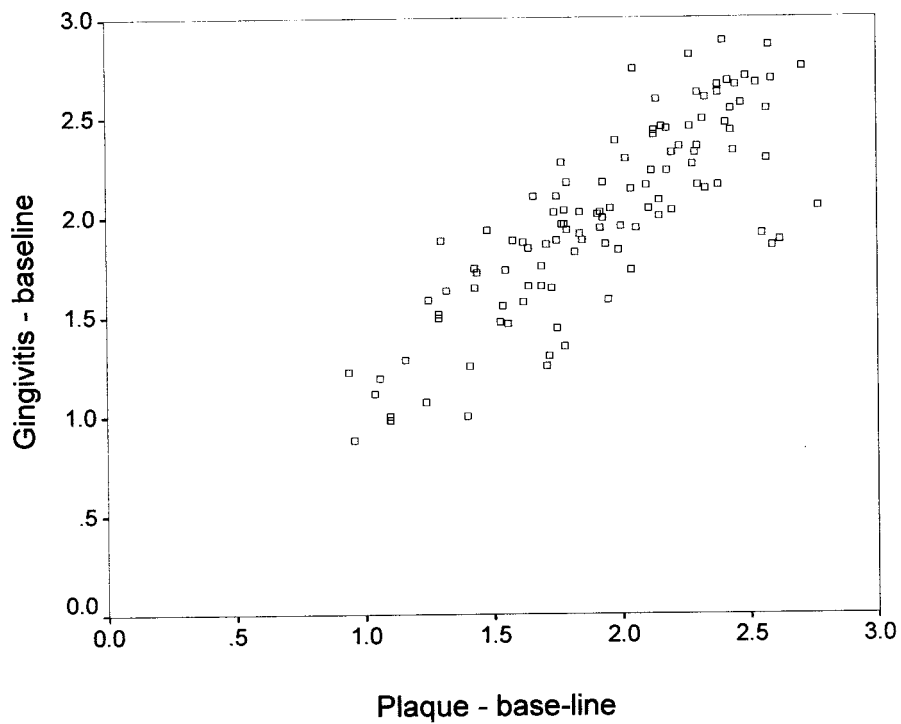


Fig. 8. Scattergrams of the Plaque and Gingival indices at baseline and in the final examination.

6. DISCUSSION

Methodological aspects

Study design

Sample size and proportion of the different disability groups was representative as the total population of disabled children and young adults with sensory, physical and developmental disabilities in the government special needs schools were examined. As it was a capture sample, no special sampling methods were required. The institutionalized disabled and the disabled in private schools were not included in these studies.

Clinical data

Confidence in the results of any study must depend on the sensitivity and specificity of the indices used and on the examiner variability.

DMF index

For scoring dental caries, the DMF index was used; this is a well-accepted measure of caries prevalence and may reflect the actual caries experience within the population studied. The DMF index was applied to whole teeth (designated as DMFT) or to surfaces (DMFS). It is a simple and versatile index. Evidence of caries is manifested in various ways: as teeth and tooth surfaces with open carious cavities (D), as filled teeth and surfaces (F) and as missing teeth (M) extracted because of extensive destruction by the caries process (Klein & Palmer 1940). So only teeth missing due to caries were previously included in the DMFT index. However, Code 5 (WHO, 1997b) scores permanent teeth judged to have been extracted for orthodontic reasons or due to periodontal disease, trauma, etc.

Dental caries is recorded when softened floor, undermined enamel and softened wall have been detected. The advantage of this diagnostic criterion is that the DMFT index reflects the level of cavitations with presumptive involvement of dentine showing intervention is indicated (Downer, 1989). Examiner repeatability is also likely to be optimised. Hence the DMFT index fulfils the purpose of the survey, which was to estimate the number of cavities in the population needing restorations. However, it is known that lesions that are clinically diagnosable in an epidemiological study indicate only the prevalence of lesions that have

progressed to a certain stage, and not the actual caries experience of the individuals in a given population (Manji & Fejerskov, 1990). With modern preventive and restorative technology, the DMF index is becoming outdated as a measure of caries attack; it may be more valid as a measure of treatment received (Burt & Eklund, 1999). The limitations of DMF index are: 1) DMF values are not related to the number of teeth at risk. 2) The DMF index gives equal weight to missing, untreated decay, or well-restored teeth. 3) It is invalid when teeth have been lost for reasons other than caries. 4) It can overestimate caries experience in teeth with “preventive restorations.” 5) DMF data are of little use for estimating treatment needs. 6) DMF cannot account for sealed teeth.

Though proximal caries cannot be reliably detected without proper artificial light or fiber-optic light, x-ray, it was not possible to use these aids in these schools in this study. The results concerning caries experience most probably therefore are underestimations of the true situation.

James index

Oral hygiene indices have been difficult to standardize and reproduce. The index described by James & colleagues (1960) is simple, easy to use and has been found to be reproducible (MacLaurin et al., 1985b).

CPITN index

In this study, the Community Periodontal Index for Treatment Needs (CPITN) has been used to assess periodontal condition and needs. Epidemiological assessments of periodontal conditions and treatment needs pose complex problems. Assessment of biological and pathological periodontal status provides a mix of information on past and present disease yet may not be of value as an indicator of treatment requirements. Assessment of treatment requirements, however, has wide implications in planning for both treatment programmes and personal requirements. CPITN has been recommended as a practical screening process for estimating the need for treatment of periodontal disease. The clinical criteria, use of a periodontal probe and identification of treatment needs support the recommendation of CPITN as the index of choice for screening in epidemiological surveys.

Ainamo et al. (1982) introduced the CPITN at the instigation of the World Health Organization (WHO) so that health authorities could develop appropriate preventive and treatment services for large communities. It is a composite index that combines features of gingivitis and periodontitis. Minor modifications to the CPITN have been made since its inception, and current recommendations for use of the CPITN have been summarized by WHO (WHO, 1997b).

A review of the epidemiological procedures for describing the prevalence and severity of periodontal disease and treatment needs concluded that the most useful combination of clinical criteria was: gingival bleeding, calculus and pocketing (WHO, 1978). It was also recommended that, for epidemiological purposes, the periodontal assessment should be based on examination of a few selected teeth rather than all teeth, and from these recommendations the CPITN developed (Ainamo et al., 1982).

The most common use for CPITN has been in identifying the prevalence and severity of periodontal conditions with respect to treatment needs (Cutress et al., 1987). For this purpose, it is assumed that the periodontal conditions occur hierarchically, not only in terms of treatment needs, but also in terms of presence of conditions ranked lower in the scoring system. Previous studies have stated that the chosen index teeth are representative of the worst condition of the sextant (Ainamo et al., 1982).

The CPITN procedure is recommended for epidemiological surveys of periodontal health and provides guidance on planning and monitoring of the effectiveness of periodontal care programmes and the dental health personnel required (Cutress et al., 1987). CPITN is a procedure that uses clinical parameters and criteria relevant to planning for the prevention and control of periodontal diseases and is not intended as a comprehensive assessment of the total past and present experience of periodontal disease (Cutress et al., 1987). The CPITN records the common treatable conditions, namely periodontal pockets, gingival inflammation, calculus and other plaque retentive factors. However, it does not record irreversible changes such as recession or other deviations from periodontal health such as tooth mobility or loss of periodontal attachment (Cutress et al., 1987).

The main advantages of CPITN are simplicity, speed and international uniformity; and its limitations include partial recording, exclusion of some important signs of past periodontal breakdown and absence of any marker of disease activity or susceptibility (Cutress et al., 1987). It requires minimal equipment and offers the possibility for goal setting (Pilot &

Miyazaki, 1994). The CPITN is primarily a screening procedure for identifying actual and potential problems posed by periodontal diseases both in the community and in the individual, and with this information appropriate oral care services can be planned for populations and for individuals.

Compared with other epidemiological indices for periodontal health, the CPITN is not only simple and practical but is also more objective in its choice of clinical criteria and methodology and offers rapid appreciation of the periodontal condition of a population, its treatment needs and the personnel required (Cutress et al., 1987). Several studies validate the use of the CPITN (Cutress, 1986); and essentially, they conclude that the CPITN is a simple and appropriate procedure for recording periodontal conditions and relating them to the amount of care provided.

As the first level of intervention in the CPITN system, periodontal care is based on health promotion and education leading to improved oral hygiene (Pilot & Barmes, 1987). But most importantly, it has been shown that at the community level the CPITN index is sensitive enough to detect changes after implementation of a programme of oral health care (Songpaisan & Davies 1989; Cutress et al., 1991). On a population level, the need for periodontal treatment is defined as the intervention needed to change the existing periodontal condition to the described goal (Gjeramo, 1991). Interpretation of the results of CPITN surveys in terms of treatment need has led to some misunderstanding and to questioning of the value of CPITN data for planning oral health care and provision of personnel (Pilot & Barmes, 1987). For example, direct translation of calculus measurement into treatment need creates an unattainable treatment burden for some populations (Manji & Sheiham, 1986). Recently it was reported that the index has hardly ever been used for planning purposes (Baelum & Papapanou, 1996).

The limitations related to the CPITN index have arisen either because the index has been adopted for purposes other than those for which it was designed or because recent advances in our understanding of the disease process question the basic underlying assumption of the index (Holmgren, 1994). The limitations of CPITN have been summarized in six points: 1) difficulty with reproducibility/validity, 2) recording of index teeth, 3) no marker of disease activity or prognostic indicator for future periodontal breakdown, 4) hierarchy of the scoring, 5) exclusion of attachment loss, and 6) may be too simple and crude (Pilot & Miyazaki, 1994). However, in this study the CPITN index was chosen as an appropriate index at the baseline surveys to record the periodontal condition and the treatment need.

Dean's index

In general, Dean's index serves the purpose of measuring the maximum dental effects of fluoride exposure that are important in determining a safe level of exposure to fluoride in drinking water. Dean's index has been used for scoring dental fluorosis because of its simplicity and usefulness in making comparisons with numerous earlier studies (Kumar et al., 1999). The index is a suitable instrument for monitoring how minor adjustments to the fluoride concentrations in drinking water affect dental fluorosis, and it has been concluded that the index is a suitable instrument for measuring the relation between fluorosis and levels of fluoride in water (Evans, 1989).

However, some investigations have pointed out the limitations of Dean's index (Thylstrup & Fejerskov, 1978; Fejerskov et al 1988; Clarkson, 1989). These limitations can be summarized under three major points. The first two points are: 1) the index presupposes that the condition and the diagnostic criteria are unclear, imprecise or not sensitive enough. For example, the code "questionable" used for the second category has created confusion. 2) It is unclear whether Dean used this term to indicate his uncertainty over the effects of fluoride on enamel at low levels of exposure, or diagnostic difficulties that he might have experienced, or his belief that this degree of fluorosis did not cause enough aesthetic concerns to merit full consideration in an index (Rozier, 1994). However, these findings concerning the "questionable" category are no longer justified (Fejerskov et al., 1988). A third general criticism of Dean's index relates to its use of either the person or the community as the unit of measurement. Detection of fluorosis grades 1-2 without drying and artificial light is difficult and there are uncertainties in these figures in this study.

Silness and Löe plaque index and Löe and Silness gingival index

In this study the Silness & Löe plaque index (1964) and Löe & Silness gingival index (1963) were used to score plaque and gingivitis. While all the indices published prior to 1963 were based on the single tooth as a unit, these newer indices evaluate every single tooth surface. In the early 1960's, Löe & Silness made an epochal contribution to the scoring of plaque and gingivitis abandoning the combined gingival and periodontal indices and in their Gingival Index (Löe & Silness, 1963) concentrating on determination of different degrees of inflammation within the region of the marginal gingiva. Correspondingly, for determination of the effect of oral hygiene measures, they proposed in the Plaque Index (Silness & Löe, 1964)

determination of the thickness of the plaque at the gingival margin, rather than its coronal extension. The development and presentation of the Gingival Index (GI) system by L  e & Silness (1963) and the Plaque Index system (PII) by Silness & L  e (1964) opened up a new era in experimental epidemiology, and these indices are still widely used. The Plaque Index is a reliable measure for evaluating mechanical anti-plaque procedures. The Gingival Index has also gained wide acceptance as a simple, accurate and reproducible method for evaluating gingival health or disease in epidemiological and clinical research (Lang, 1998).

Results

Oral health status

This is the first comprehensive oral health survey of the disabled population in Kuwait (I, II, III, IV). This survey reinforces and adds information pertaining to differences in severity and prevalence of disease between disabled and normal children and according to disability group. The results have shown that poor oral health is a major problem for disabled schoolchildren, and the oral health of disabled children assessed seemed to indicate a cumulative neglect of oral health. The lack of regular dental care, which is available to normal schoolchildren, was reflected in the dental status of the disabled when their oral health was compared with that of normal schoolchildren. In comparison with normal children, the disabled subjects were not given enough dental care with respect to their treatment need. According to recent literature, individuals with any kind of disability or illness usually have poor oral health compared with the general population. The interpretation of this finding probably has to do with poor oral hygiene, undesirable side-effects of medications, the high degree of neglect of their dental needs, owing to the severity of other systemic health problems or problems related to dental management (Dicks, 1995).

Dental caries experience (I)

The number of children aged 3-5 years was small, but the descriptive results were reported because capture sample was used and all disabled schoolchildren in these age groups were examined. Although there were 144 individuals over 16 years in the sample, they could not be excluded from the study because of ethical reasons. Age was controlled (standardized) in the analyses. Fig. 1 describes the mean dmft index according to age groups. The decline of dmft index in older age groups in all the disability conditions obviously follows the natural exfoliation of primary teeth.

It was evident that the caries experience of the disabled group who were attending 'special' schools was higher than that found in national oral health surveys of children in normal schools in 1993 (Vigild et al., 1996) and in 2000 (Soparkar et al., 2001; Al-Mutawa et al., 2002), which also adhered to the WHO methodology.

The present results showed clearly that among normal schoolchildren (Al-Mutawa et al., 2002) more and higher percentages have caries-free primary and permanent dentitions than do disabled. The age-specific caries-free percentages in both the dentitions were higher in normal schoolchildren than in the disabled in this study (Figs. 9 & 10). The age-specific mean dmft values recorded were higher in the disabled than in normal children (Fig. 11); and with the exception of the 6-year-olds, the age-specific mean DMFT values were also higher in the disabled (Fig. 12). Study of the comparison population of normal schoolchildren in 2000 (Soparkar et al., 2001) also showed a higher percentage of restorative care (filled component) compared to the special needs population, indicating greater accessibility to restorative care by normal schoolchildren. In 5 - 12 year-olds the f-component was 28% in normal children compared to 8.8% in the special needs children. In 6 - 14 year-olds the F-component was 20% in normal children compared to 6.9% in children with special needs.

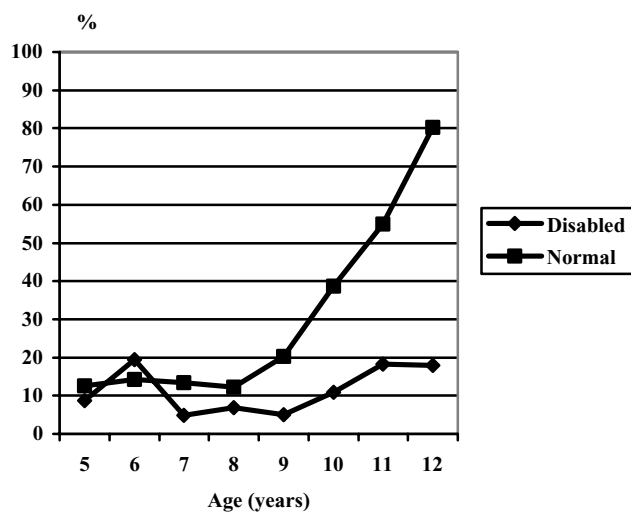


Fig. 9. Proportions (%) of caries-free children in primary dentition of disabled (1999) vs. normal children (2000) by age.

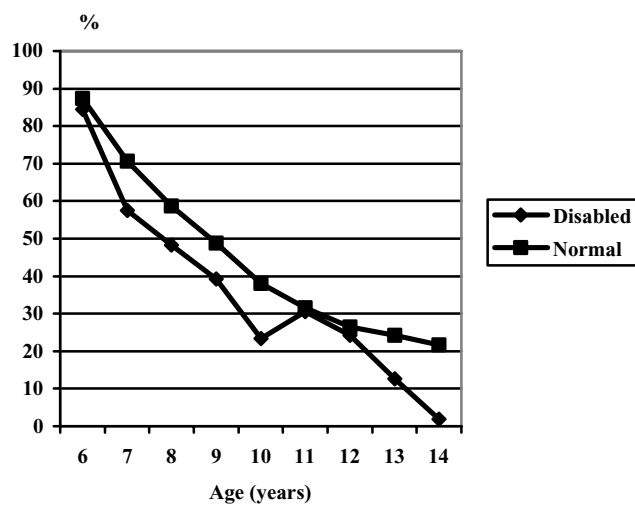


Fig. 10. Proportions (%) of caries-free children in permanent dentition of disabled (1999) vs. normal children (2000) by age.

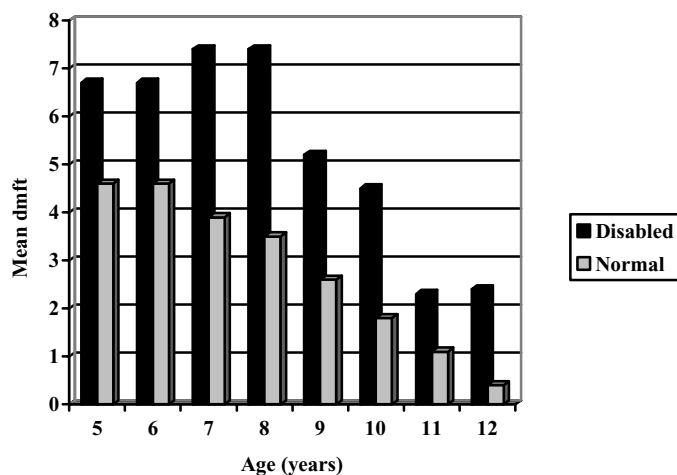


Fig. 11. Mean dmft of disabled (1999) vs. dft of normal children (2000) by age.

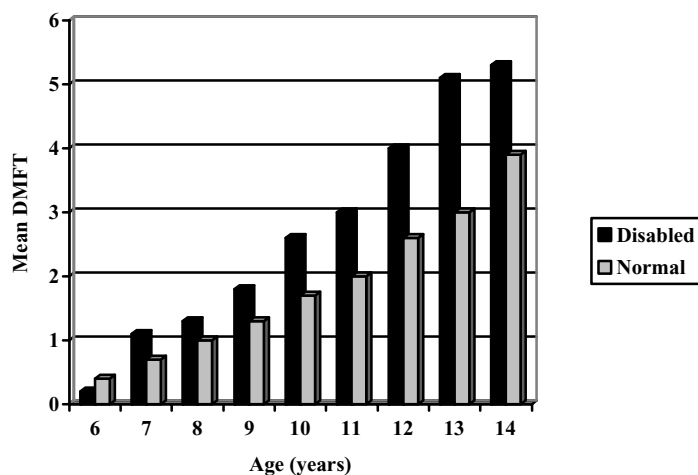


Fig. 12. Mean DMFT of disabled (1999) vs. normal children (2000) by age.

The present study reports a higher prevalence of untreated carious lesions in the disabled than in normal children, thus agreeing with previous findings suggesting that the severity of caries attack is essentially the same in disabled and normal schoolchildren but that the rate of treatment is frequently lower in the disabled (Murray & Mcleod, 1973; Brown & Schodel, 1976; Tesini, 1981; Palin-Palokas et al., 1982; Storhaug, 1985; Shaw et al., 1986; Nunn, 1987; Nunn & Murray, 1987; Storhaug & Holst, 1987; Vignasha et al., 1991; Gupta et al., 1993; Ohito et al., 1993; Gizani et al., 1997; Mitsea et al., 2001). This study showed that there was a high demand for provision of dental services, especially to the disabled, and that this population has received less dental treatment. When the individual components of the mean DMF values were examined, disparities were apparent when these subjects with disabilities were compared to normal children. Marked differences between normal and disabled children have previously been reported in the component parts of the mean DMF (Murray & Mcleod, 1973; Nunn & Murray, 1987; Ohito et al., 1993; Haavio, 1995; Gizani et al., 1997). The trends in this study are similar to those found in other studies, and the results are of clinical importance. The treatment provided in the primary and permanent dentitions differed considerably between disabled and normal children, which emphasizes the fact that disabled children are receiving less dental care than their normal counter-parts.

In spite of the high level of disease, the treatment received was very low; and considering the treatment needs, in the present investigation the decayed index was much higher than the missing and filled indices (d was 82.2%, D was 84.0%) in both dentitions and needed some kind of dental treatment. In 2000, the percentage of the dmft score represented by untreated decay in 5 - 12 year-olds was 69% in the normal schools compared to 83% in the disabled. The percentage of the DMFT score represented by untreated decay in 6 - 14 year-olds was 89% in the disabled compared to 54.6% in the normal schools (Soparkar et al., 2001). The interpretation of this finding is that in the disabled there were many more decayed teeth than missing or filled teeth in both dentitions. This study showed that there was a high demand for dental services in particular for the disabled, and that this population has received less dental treatment. This finding is in agreement with previous studies, which reported that the level of restorative treatment was below that in normal children (Tannenbaum & Miller, 1960; Swallow, 1972; Murray & McLeod, 1973; Naoh, 1982; Mann et al., 1986; Shaw et al., 1986; Nunn & Murray, 1987; Ohito et al., 1993; Haavio, 1995; Gizani et al., 1997; Mitsea et al., 2001).

In general, the amount of decay may be similar or even greater for the normal group, but the disabled will have more missing teeth and fewer filled teeth (Nunn & Murray, 1987; Holland & O'Mullane, 1990; Pope & Curzon, 1991). The teeth of individuals with various handicapping conditions were more likely to be extracted than restored (Nowak, 1984). This difference could be explained by the perception that, although dentistry enhances quality of life, it does not prolong life. The inability of these groups to follow home care regimens may also be an important factor. It has also been shown that the parents of disabled children often become pre-occupied with the medical and social problems they have to face and disregard the need for dental care (Eisenberg, 1976). The most important reasons for failure to treat patients with disability conditions were that few sought care on their own and that there was a lack of interest on the part of the dental profession (Entwistle, 1980). It is known that the prevalence of caries is dependent on factors like living environment as well as dietary and hygiene habits (Dicks, 1995; Morinushi et al., 1995; Shapira et al., 1996; Stefanidis et al., 1999). There is also a trend indicating increased possibility of developing dental caries when the recall intervals are long (Maurer et al., 1996). Evidently the individuals who were disabled did not receive adequate dental care.

In the present study, differences in the prevalence and severity of the dental conditions assessed among children in the various disability groups were significant. An evaluation of the DMFT score revealed that the group with Down syndrome had a much higher mean DMFT component and total scores than the other disability groups did. The type of disability significantly influenced caries experience (mean dmft, DMFT), being highest in Down syndrome and lowest in the blind. This is in agreement with earlier studies where there was difference in caries experience between disability groups (Gupta et al., 1993; Ohito et al., 1993; Bhavsar & Damle, 1995; Mitsea et al., 2001). The lowest caries experience observed in the blind group in the present study coincides with that found in other studies (Bhavsar & Damle, 1995; Mitsea et al., 2001). These children probably were able to function well manually and intellectually in terms of oral health. In some earlier studies, the highest caries experience was observed in children with mental retardation (Gupta et al., 1993) or with combined mental and physical handicaps (Ohito et al., 1993), or in children with physical handicaps (Ohmori et al., 1981). In contrast, in other studies no significant differences in caries experience were found among groups with disabilities (MacLaurin et al., 1985a, Shaw et al., 1986; Nunn & Murray, 1987; Gugushe et al., 1991; Vignesha et al., 1991).

The prevalence of untreated decay was highest in hearing-impaired (86%). In a study of children and adolescents with hearing defects in a Greek population, large numbers of untreated carious lesions were found and the oral hygiene was only fair (Karidis et al., 1999). In children with mild learning disabilities and children who are partly independent, the prevalence of dental caries has been higher (Palin-Palokas et al., 1982; Storhaug & Holst, 1987). Apparently these children may have fewer dietary restrictions and are therefore at greater risk for dental caries. Significant oral health differences by behaviour group, age, and dental clinic status were observed in children and adults with mental retardation (Shapira et al., 1998). Kendall (1992) stated that people with mental handicap did not constitute a uniform group, as great differences were observed in the dental health of sub-groups; and dental care for the non-institutionalized mentally handicapped living in the community cannot be planned with the assumption that they are a homogenous group. Among adults with disabilities living in the community, those who were ranked as having less mental retardation had better oral hygiene, less gingival inflammation, more fillings and fewer teeth extracted due to caries. In contrast, in Sweden caries prevalence was lower in an institutionalized mentally retarded group than in groups with more independent living arrangements (Gabre & Gahnberg, 1994).

The percentage of subjects with sealants was 34.2%. In an earlier study, only 2 special needs patients out of 296 examined, had fissure sealants in place (Costello, 1990). The prevalence of sealants was highest among the blind and the hearing impaired in this study. This is mostly because these groups are the most cooperative to treat. In a recent study, the highest percentage of children with hearing impairments had sealants compared to the other disabilities (McAlister & Bradley, 2003).

No difference between genders was found in this study in caries experience and treatment needs in either dentition. This finding is in agreement with most of the dental literature about gender-related differences in caries experience; and similar to this study, the majority of studies did not identify gender differences in dental disease experience and treatment need (MacLaurin et al., 1985a; Evans et al., 1991; Francis et al., 1991; Gugushe, 1991; Vignesha et al., 1991; Gupta et al., 1993; Ohito et al., 1993). As no differences were found between males and females, it is probable that behavioural differences are of less importance in this disabled population. In contrast, in a group of physically handicapped children in the UK, a higher experience of caries in both dentitions was observed in girls and this difference extended to treatment need for the permanent dentition, where more girls than boys were recorded as requiring treatment and girls had nearly twice the number of untreated caries as boys (Nunn et

al., 1993). In a group of developmentally disabled, more females were assessed as having superior oral health compared to males (Linderman et al., 2001).

There were no significant differences between caries experience in maxillary and mandibular teeth in the primary and permanent dentitions. In contrast, in handicapped children of India, higher caries experience was recorded in mandibular teeth compared to maxillary teeth (Gupta et al., 1993). The caries experience of the first permanent molars represented the largest proportion of the DMFT score and agrees with an earlier study (Gizani et al., 1997). Because of their early eruption, their position in the posterior region and their occlusal morphology, first permanent molars very often show decay and also are likely to become carious at an early age (Gizani et al., 1997). The proportion of subjects with sealants was highest among the blind and lowest among those with Down syndrome. Lack of compliance among the group with Down syndrome may have prevented the successful placement of fissure sealants.

Oral hygiene was the strongest explanatory factor for caries prevalence, and poor oral hygiene (OR = 2.82) was significantly associated with caries risk in the permanent dentition. In an earlier study on Finnish children with mental retardation, the most important determinant of caries risk was their poor standard of oral hygiene and frequent use of sugar-sweetened snacks (Palin-Palokas et al., 1987). It has been documented that persons with handicapping conditions have poor oral hygiene (Smith et al., 1966; Full et al., 1977; Naoh, 1982; Nicolaci & Tesini, 1982; Mitsea et al., 2001; Seymen et al., 2002). In the group with Down syndrome too, poor oral hygiene (OR = 4.50) was associated with caries risk. It has been demonstrated that poor oral hygiene, which is directly associated with plaque score, contributes to high prevalence of dental caries in people with Down syndrome (Kroll et al. 1970). Although the role of oral cleanliness as a determinant of caries risk is, in general, regarded as controversial, a very poor level of oral hygiene seems to be associated with increased caries risk (Bellini et al., 1981a). It has been documented that dental plaque is an important etiological factor for dental caries (Ekstrand et al., 1998). Other researchers (Cutress, 1971b; Nowak, 1977) have also found that those groups with the highest caries prevalence had the highest oral hygiene scores. However, other variables may also be more important in understanding the relatively high caries rate in this population. A highly cariogenic diet is also a significant factor (Gustafsson et al., 1954). These subjects may often receive a highly cariogenic diet in-between-meals in the form of refined carbohydrates. Moreover, the subjects may be living in a less supervised environment with poor dietary control and lack of oral hygiene supervision. In addition, sweetened medications are frequently used in the treatment of medical infections, which are prevalent in

these populations (Fiegal & Jensen, 1982). In disabled pre-schoolchildren in Norway, age, the number of daily carbohydrate intakes, duration of using a nursing bottle, family income and diagnosis were the variables that had the strongest association with dmft (Storhaug, 1985).

In this study, as in most studies, increasing age was significantly associated with caries experience. In general, there is a steady increase in DMF rates according to age, because caries can only increase with age (Tesini, 1981). Creighton & Wells (1966) used a mathematical linear regression model to analyze the effect of age and number of erupted teeth on caries experience. For determining the relative differences of DMF teeth, age alone was a much more important factor than number of erupted teeth. Because age is often a confounding factor in comparing different groups, in comparing the groups in this study, the figures for mean caries-free proportions and caries experience were age standardized (Tables 1 & 2). Because a capture sample was used, the sample figures were presented without age standardization (I; Table 2 & 3). In both dentitions the dental caries experience was highest in subjects with Down syndrome. The subjects of this study were non-institutionalized and living at home, where diet is presumably not regulated and many subjects might have received a high cariogenic diet. Prolonged retention of food particles in the oral cavity might have resulted in a higher prevalence of caries.

The results of previous studies on the dental caries experience of subjects with Down syndrome have been controversial. From the epidemiological data available to date there is conflict in the views of caries susceptibility in Down syndrome children. Caries occurrence has been reported to be both higher (Kroll et al., 1970; Rosenstein et al., 1971; Gupta et al., 1993) and lower (Johnson et al., 1960; Brown & Cunningham, 1961; Winer & Cohen, 1962; Cohen & Winer, 1965; Creighton & Wells 1966; Wolf, 1967; Cutress, 1971a; Stabholz et al., 1991; Pueschel & Pueschel, 1992; Morinushi et al., 1995) in subjects with Down syndrome compared with non-Down syndrome subjects or other individuals with mental retardation. However, some studies have found no difference in caries experience compared with normal non-Down syndrome groups (Swallow, 1964; Gullikson, 1973; Steinberg & Zimmerman, 1978; Maclaurin et al. 1985c; Vigild, 1986; Ulseth et al., 1991; Yarat et al., 1998; Seymen et al., 2002). In the present study (I), in the cohort of children with Down syndrome, dmft and dmfs scores were higher than DMFT and DMFS scores. Similar to these results, in the study of Seymen et al. (2002), the dmfs scores were higher than the DMFS scores. Latner (1983) reported that there is no difference in caries experience among the three genotypes (Trisomy-21, Translocation, and Mosaicism) for Down syndrome.

The earlier literature (Nunn, 1984) indicated that caries prevalence was lower in Down syndrome children, with 50 and 84% reported to be caries free (Maclaurin et al., 1985c; Ulseth et al., 1991). The reasons put forward for this relative caries immunity are various, ranging from differences in tooth eruption and tooth form to biochemical differences in salivary buffering (Vigild, 1986). Living environment, dietary and hygiene habits (Kroll et al., 1970; Swallow, 1964; Takeda et al., 1989) fewer erupted teeth due to a high frequency of hypodontia (Swallow, 1964; Cutress, 1971a; Vigild, 1986) and different proportions of salivary components compared to normal children (Cohen & Winer, 1965; Vigild, 1986; Jara et al., 1991) have been proposed as the reasons for the low prevalence rate of caries in Down syndrome. Delayed eruption, reduced time of exposure to a cariogenic environment, congenitally missing teeth, higher salivary pH and bicarbonate levels, microdontia, spaced dentition, and shallow fissures of the teeth, all contribute to lower risk of dental caries (Chan, 1994). In individuals with Down syndrome, the prevalence is lower and it has been theorized that this may be due to delayed eruption of teeth, increased spacing between teeth or possible differences in chemical composition of the saliva (Morinushi et al., 1995). Swallow (1964) found no difference in caries experience between children with Down syndrome and other mentally handicapped children. More recent studies, however, have shown that while the prevalence is lower, it is not as low as was once thought and it should not be assumed that people with Down syndrome would not develop dental caries (Barnett et al., 1986).

Older studies of caries in individuals with Down syndrome have concentrated on institutionalized populations whose diets were controlled (Boyd & Cheyne, 1947; Johnson et al., 1960, Brown & Cunningham, 1961; Winer & Cohen, 1962; Creighton & Wells, 1966; Wolf, 1967). These groups may not have had the same exposure to cariogenic foods as today's children with Down syndrome who are growing up at home. Institutionalized subjects with Down syndrome have lower caries prevalence than those living at home, probably as a result of differences in environment (Cutress, 1971a; Forsberg et al., 1985; Vigild, 1986; Ulseth et al., 1991). Freedom from caries in patients with Down syndrome does not appear to be related to oral cleanliness (Brown & Cunningham, 1961), and much research has been carried out on the aetiology of caries (Yarat et al., 1998; Benjamin et al., 1999). Considering the type of food served and the standard of oral hygiene that can be attained, an unusually low prevalence of dental caries has been found in Down syndrome (Brown & Cunningham, 1961).

Caries incidence and increment (V)

In this incidence study, two series of measurements among the same subjects at different times (in 1999 and 2001) were done to determine the proportion of the new individuals with caries over this specified time period. The incidence percentage was calculated as the percentage of new subjects who got caries in the 2-year period (1999-2001).

Because the group with Down syndrome had the highest caries experience (I), that group was chosen as a target group for further investigation. In this study of caries incidence and increment (V) the group with Down syndrome had a high score for caries increment. Although no control group of healthy children was available in this study, the caries incidence and increment figures were clearly higher than the estimated figures from a recent cross-sectional oral health survey of children who were non-disabled in (Soparkar et al., 2001; Al-Mutawa et al., 2002). The caries increment figures (DMFT, DMFS) were higher than in the normal children, although the probability for caries occurrence was lower due to the lower number of teeth because of congenitally missing teeth.

The caries increment was highest in the 14 – 15 year-olds and in older than 17 year-olds. This is to be expected as teeth erupt later in Down syndrome, so more premolar and second molar teeth would have been susceptible in the older age groups.

The incidence of dental caries (V) was highest on occlusal surfaces (13.3%). Carious lesions in Down syndrome often appear to be limited to occlusal surfaces (Steinberg & Zimmerman, 1978; Barnett et al., 1986; Vigild, 1986). In a three-year study of incremental caries scores in subjects with various mental disorders, the carious lesions in the group with Down syndrome appeared to be limited to the occlusal surface (Steinberg & Zimmerman, 1978). In some earlier studies, the group with Down syndrome had the lowest caries incremental scores (Johnson et al., 1960; Winer & Cohen, 1962; Steinberg & Zimmerman, 1978). In another study, the markedly lower prevalence of dental caries observed in a group with Down syndrome was attributed largely to the extremely low prevalence of interproximal caries (Barnett et al., 1986). Although individuals with Down syndrome are susceptible to caries, the increment of approximal caries is low, probably due to the fact that these subjects have wider spacing (Vigild, 1986).

Oral hygiene and periodontal conditions (II)

The disabled subjects attending special needs schools had a poorer standard of oral hygiene and greater prevalence of calculus and periodontal disease than that found in normal children of comparable age groups (II). These results confirm the findings of other studies concerning the poor level of oral hygiene and high prevalence of periodontal disease among individuals with disabilities (Cutress, 1971b; Murray & McLeod, 1973; Brown & Schodel, 1976; Svatun & Gjermo, 1978; Tesini, 1981; Naoh, 1982; Mann et al., 1984; Holland & O'Mullane, 1986; Shaw et al., 1986; Nunn, 1987; Nunn & Murray, 1987; Vignesha et al., 1991; Ohito et al., 1993; Bhavsar & Damle, 1995; Gizani et al., 1997; Martens et al., 2000; Mitsea et al., 2001; Seymen et al., 2002).

The results of this study are also in agreement with those for similar population groups in terms of the findings of poor oral hygiene and extensive gingivitis. Although comparisons with proper control groups are rare, in the disabled the standard of oral hygiene has consistently been reported to be poor (Cutress, 1971b; Murray & McLeod, 1973; Shaw et al., 1986; Nunn & Murray, 1987; Francis et al., 1991; Gizani et al., 1997; Martens et al., 2000).

With regard to oral hygiene status, individuals with vision problems had better oral hygiene than did other disabled groups. This is in agreement with the findings of earlier studies where the children with sensory disabilities had better oral hygiene and gingival health than other children with disabilities (Nunn & Murray, 1987; Mitsea et al., 2001). Subjects who are blind probably are able to function well manually and intellectually with regard to oral health. It could be interpreted that these individuals can comprehend oral hygiene instructions better and also have better kinetic skills. On the other hand, this seems to contrast with the difficulty of these individuals to see and remove plaque (Haavio, 1995). It was noted that oral hygiene scores improved with age in children who are partially-sighted, while oral hygiene was worst in the totally blind (Greeley et al., 1976), probably because children who are partially sighted are more perceptive and conceptual than youngsters who are blind. Relatively poorer level of oral hygiene and higher prevalence of periodontal disease were found in the totally blind compared to the partially blind and the sighted. The mean OHI-S did not vary with age in either the totally blind or partially sighted group (Anaïse, 1979). Children with hearing impairment and communication problems had much better oral hygiene than the other disability conditions (Shaw et al., 1986).

The proportion of subjects with good oral hygiene was lowest in the Down syndrome (8%) and physically handicapped groups (16%). The most probable reason for this difference in oral cleanliness is the physical limitations of the physically handicapped and the inability of the mentally handicapped, such as those with Down syndrome, to master the techniques required for toothbrushing. The plaque index could be higher due to exogenous factors, which can be divided into primary local factors, such as lack of oral hygiene or calculus, and secondary local factors, such as tongue thrusting, malocclusion and lack of lip seal (Cohen et al., 1971). The most obvious reason for poor oral hygiene in a physically handicapped child is physical inability to clean the oral cavity adequately and probably a lack of self-discipline because of over-protective parents. In a study of 12-year-old Belgian children who are disabled, children who were mildly mentally retarded and learning-impaired had significantly better manual dexterity skills than the moderately and severely mentally retarded and the physically impaired. However, this was not reflected in improved oral hygiene for the former group (Martens et al., 2000).

There were no gender differences in oral hygiene status in this study. This may be due to the type of disability being the dominant influence affecting oral hygiene rather than the gender. It has been suggested that girls tend to practice better oral hygiene than boys because of their greater social awareness, and thus their oral hygiene is superior to that of boys (Sutcliffe, 1972; Dummer et al., 1987). In normal children, gingivitis occurs more often in boys than in girls; and the observed peak in the prevalence of gingivitis at eleven and twelve years was probably related to hormonal factors (Sutcliffe, 1972). In a group of developmentally disabled, more women than men were assessed as having good oral hygiene (Lindermann et al., 2001); and it can be interpreted that women pay more attention to their personal hygiene than men do.

The commonly accepted recommendation for toothbrushing frequency has been twice a day (Frandsen, 1986). In this study, more than half of the subjects reported brushing according to this general advice, i.e. at least twice a day. A considerable percentage (20%) of the mildly mentally retarded and learning impaired children did not brush daily; most did not receive help with toothbrushing from their parents or caregivers (Gizani et al., 1997). Most of the mentally retarded in Norwegian institutions were unable to brush their teeth (Svatun, 1974). About 80% of out patients and about 40% of institutionalised mentally retarded children and adolescents were able to brush their teeth (Tesini, 1980). In the present study, half of the subjects with Down syndrome did not receive help in toothbrushing from their parents or caregivers, compared to more than 90% in a Belgian study (Gizani et al., 1997). This fact may be part of

overall parental neglect of these children in relation to other basic health measures or may reflect the attitude that oral health lacks importance in the overall scheme of health management. A questionnaire study showed that children with Down syndrome have poorer dental health practices than normal children do (Randell et al., 1992). It was indicated that children with Down syndrome were receiving less help with toothbrushing from their parents compared to normal children (Randell et al., 1992). About 60% of severely mentally retarded children were found to be totally dependent on help with toothbrushing and only 5% were able to brush without supervision (Forsberg et al., 1985). In a study of disabled pre-school children in Norway, about half of the parents had difficulties brushing their children's teeth (Storhaug, 1985). Lindemann et al. (2001) reported in their study that a majority of the developmentally disabled (73%) brushed their own teeth and for the remaining 27%, brushing was a caregiver's responsibility. Details are scant as to the number of children in special needs schools who are reported, by parents, to clean their teeth themselves, ranging from 28 - 64% (Costello, 1990; Nunn & Murray, 1990). Younger children (age 2-5 years) are more likely to get help with brushing than older children (Nunn & Murray, 1990). In a recent study, 63% of children (5, 8, 12, 15 years) with disabilities were reported to brush their own teeth (McAlister & Bradley, 2003).

Both in bivariate (OR = 10.7) and in multivariate analysis (OR = 8.5) oral hygiene was the most significant risk factor for occurrence of periodontal disease. A high correlation between poor oral hygiene and the development and progression of periodontal disease has been well documented and the role of poor oral hygiene as a risk factor of periodontal diseases is well established (Suomi, 1972; Bellini et al., 1981b; Page, 1986).

Prolonged retention of food particles in the oral cavity might result in more gingival inflammation and eventually lead to periodontal disease. According to some investigators (Shaw et al., 1986; Nunn & Murray, 1987), there seems to be a correlation between the level of oral hygiene and severity of the handicap; and lack of proper oral hygiene has been suggested to be the principal cause of periodontal disease in individuals with handicapping conditions. The high prevalence of poor oral hygiene among handicapped individuals is usually more evident in the mentally retarded, and a lack of proper oral hygiene has been implicated as one of the primary factors influencing the prevalence of disease in this population (Snyder et al., 1960; Goyings & Rieske, 1968; Till & Dicks, 1973; Full et al., 1977; Nicolaci & Tesini, 1982). Mentally retarded children were least often found to have good oral hygiene and required most periodontal treatment (Shaw et al., 1986). Evidence from several sources has shown that the

primary etiological factor for gingivitis and periodontitis is bacterial plaque that forms on tooth surfaces adjacent to the gingival tissues (Goldman, 1986).

High prevalence of periodontal disease and the greatest treatment needs were detected in subjects with Down syndrome. This relatively high level of periodontal disease and treatment need in this group compared with normal and other disability groups confirmed previously reported data on the high prevalence of periodontal disease in populations with Down syndrome (Cohen & Cohen, 1971; Cutress, 1971b; Saxen et al., 1977; Brown, 1978; Saxen & Aula, 1982; Vigild, 1985a; Barnett et al., 1986; Desai, 1997). Several investigators have reported a significant correlation between oral hygiene and periodontal conditions in children with Down syndrome (Sznajder et al., 1968; Cutress, 1971b; Orner, 1976). A high degree of correlation between indices for calculus and periodontal disease was also found (Swallow, 1964; Sznajder et al., 1968; Orner, 1976).

In the subjects 15 years and over in this study, almost all needed instruction in oral hygiene and prophylaxis/scaling; and every fifth needed complex periodontal treatment. However, when the treatment need is estimated, it must be borne in mind that many subjects may not be very cooperative; and in such cases only simple treatment can be performed. Also, the group with Down syndrome seemed to be a risk factor for periodontal disease (OR = 3.6). An earlier study conducted on 60 children with Down syndrome in Kuwait showed very poor oral hygiene and increased prevalence of periodontal disease compared to the control group (El-Shennawy et al., 1993).

Individuals with Down syndrome have an increased prevalence of periodontal disease compared with otherwise normal, age-matched control groups and other mentally disabled patients of similar age (Barnett et al., 1986; Reuland-Bosma & van Dijk, 1986; Mod  er et al., 1990; Ulseth et al., 1991; Barr-Agholme et al., 1998). Cross-sectional as well as longitudinal studies indicate that the prevalence of periodontal diseases in persons with Down syndrome under the age of 30 years is extremely high and can even be noted in the deciduous dentition (Reuland-Bosma & van Dijk, 1986). Severe periodontal breakdown with horizontal bone loss is often present in the lower anterior teeth (Cohen et al., 1961; Johnson & Young, 1963; Sznajder et al., 1968; Cutress, 1971b; Keyes et al., 1971). The exaggerated immune-inflammatory response of the tissues cannot be explained by poor oral hygiene alone, but might be a result of impaired cell-mediated and humoral immunity and a deficient phagocytic system (Cichon et al., 1998). Further more, individuals with Down syndrome might have lowered or

altered resistance to bacterial infection (Saxen et al., 1977; Barkin et al., 1980; Vigild, 1985a; Scott et al., 1998). Local factors, such as macroglossia, tooth morphology, malocclusion, traumatic occlusions and lack of normal masticatory functions, have also been suggested to be influential factors for periodontal disease in individuals with Down syndrome (Barkin et al., 1980; Vigild, 1985a; Scott et al., 1998); but their effect could be considered negligible compared to oral hygiene and host resistance. The changes in periodontal tissue in subjects with Down syndrome are associated with abnormal capillary morphology and disorders in the structure of the connective tissue. In individuals with Down syndrome, change in the immunological response due to disorders in polymorphonuclear leucocytes, monocytes and T-cell function also leads to changes in periodontal tissue (Cohen et al., 1971).

The prevalence and severity of periodontal disease has also been reported to be higher in children with Down syndrome than among other mentally retarded children (Cohen et al., 1961; Johnson & Young, 1963; Swallow, 1964; Kroll et al., 1970; Cutress, 1971b; Gullikson, 1973; Saxen et al., 1977). Institutionalized children with Down syndrome have a higher prevalence and severity of periodontal disease than do those residing at home (Swallow, 1964; Cutress, 1971b; Gullikson, 1973). However, no significant differences in the disease prevalence between institutionalized and non-institutionalized children could be detected (Kroll et al., 1970).

Malocclusions (III)

Disabled subjects attending special needs schools had higher prevalence of malocclusion than normal children did, which is consistent with the results of previous studies (Swallow, 1964; Cohen & Winer, 1965; Kisling, 1966; Gullikson, 1969; Rosenstein et al., 1971; Gullikson, 1973; Vigild, 1985b; Nunn, 1987; Nunn & Murray, 1987; Orelan et al., 1987; Strodel, 1987; Pope & Curzon, 1991; Vignesha et al., 1991; Ackerman & Wiltshire, 1994; Franklin et al., 1996; Mitsea et al., 2001). Factors contributing to the high prevalence of malocclusion might be functional anomalies of the tongue, perioral muscles and particular patterns of oral habits (Vigild, 1985b). It has been suggested that malocclusion may only be increased in the most severely brain-damaged children (Brown & Schodel, 1976).

The proportion of severe malocclusion was highest in subjects with Down syndrome, which agrees with the findings of previous studies (Swallow, 1964; Cohen & Winer, 1965; Kisling, 1966; Gullikson, 1973; Girgis, 1985; Vigild, 1985b; Orelan et al., 1987; Vignesha et al.,

1991). Although different criteria have been used, the findings of this study that persons with Down syndrome have markedly increased frequencies of mandibular overjet, mesial molar occlusion, crossbite and frontal open bite compared to normal individuals agree with those of previous studies (Cohen & Winer, 1965; Kisling, 1966; Swallow, 1972; Gullikson, 1973). Increased prevalence of Angle's class III malocclusion has been recorded in a high proportion of subjects with Down syndrome (Brown & Cunningham, 1961; Swallow, 1964; Cohen & Winer, 1965; Gullikson, 1973; Vigild, 1985b; Nunn, 1987). There is an alteration in the cranial-base relationships, which predisposes individuals with Down syndrome to class III malocclusion, and an extensive skeletal basis for this finding has been reported (Kisling et al., 1966). The increase in class III malocclusions in Down syndrome children seems to be concomitant with a reduction in class II malocclusion (Brown & Schodel, 1976). Posterior crossbite and underdeveloped maxilla have been found in 58% of individuals with Down syndrome (Girgis, 1985). Higher prevalence of severe malocclusions in severely mentally retarded children, including subgroups Down syndrome, cerebral palsy and others, indicated that mental status is more important for the orthodontic status than the medical diagnosis is (Oreland et al., 1987). Vignesh et al. (1991) reported that among the various disability groups, the mentally disabled, where the majority were Down syndrome children, had proportionally more children with malocclusion, especially compared with those who had visual or hearing impairments.

The following factors may play an important role in causing malocclusion in individuals with Down syndrome: mouth breathing (96%), improper chewing (60%), evidence of bruxism (45%), tooth agenesis (12.7%), midline deviation in the maxillary arch (80%), anterior open bite (45%), dysfunction of the temporomandibular joint (24%), delayed eruption and exfoliation of both primary and secondary dentition, characteristic tongue thrust, hypotonic ligamentary apparatus of the mandibular joint, developmental disturbances of the mandible, the maxilla and the jaw relationships (Borea et al., 1990).

Reports on the prevalence of malocclusion in children with cerebral palsy are conflicting. Some investigators have found an increased prevalence of malocclusion (Lyons, 1960; Album et al., 1964; Foster, 1974; Strodel, 1987; Pope & Curzon, 1991; Franklin et al., 1996; Mitsea et al., 2001), but others have found it to be within normal limits (Gum, 1962; Magnusson, 1964; Rosenbaum et al., 1966; Miller & Taylor, 1970). Earlier studies reported malocclusions to be high in mental retardates and in those with cerebral palsy (Brown & Schodel, 1976; Nunn & Murray, 1987; Haavio, 1995; Oreland et al., 1989). This seems to be related to the abnormal or

immature oral function in children with mental retardation and cerebral palsy (Oreland et al., 1989). In a study by Mitsea et al. (2001) higher percentage of malocclusions was found in individuals suffering from cerebral palsy and mental retardation.

The prevalence of malocclusion increased with age. Because of the longer growth period of the mandible, increased prevalence of malocclusion might be expected with increasing age (Vigild, 1985b).

Traumatic injuries (III)

Published epidemiological studies on traumatic dental injuries in various parts of the world are few, and those that exist show great variation. Among Nigerian schoolchildren, 12 - 14% had traumatized teeth (Akpata, 1987); in England and Wales, 18% had incisal injuries (Bulman, 1975), while in Iraq 24.4% of the deciduous teeth of 1 to 4 year-old nursery schoolchildren in Baghdad had traumatic dental injuries (Yagot, 1988). The differences encountered when the results of various studies of dental trauma are compared can be attributed to differences in sample composition and in the classifications used.

Tooth fractures were more prevalent in subjects with disabilities than in normal schoolchildren (III). An earlier retrospective study of normal children in Kuwait detected the highest incidence of maxillofacial trauma in 15 - 19 year-olds (Al-Mahmeed et al., 1994). Disabled children are a well-established group of children who need greater supervision and are more prone to traumatic injuries (Wei, 1988). Consistent with this finding, other studies suggest that traumatic injuries are more prevalent in children with disabilities than in normal children (Greeley et al., 1976; Nunn & Murray, 1987; Costello, 1990; Ohito et al., 1992; Denloye, 1996).

The prevalence of fracture to anterior teeth in subjects with disabilities is high 16.9%, and is consistent with findings of 20% prevalence in a group of children with mental retardation (Denloye, 1996). This proportion was lower than that previously reported by Nunn & Murray (1987), who found a sizeable proportion (28.8%) of children with traumatic permanent incisors, and higher than that in the study reported by Ohito et al. (1992), where traumatic injuries of teeth occurred in 12% of the children with disabilities. However, this result is contrary to another finding where no difference was observed in the prevalence of traumatized incisors when a group of cerebral palsy and normal children were compared (Magnusson & de

Val, 1963). The prevalence was greater for children in residential care than for children in day care (Costello, 1990). The prevalence of tooth fractures was highest in subjects who were blind (24.6%), which is in agreement with another study among the blind, where 27.4% had sustained a fracture to the permanent anterior teeth (Greeley et al., 1976). In a study on visually disabled, the totally blind seemed to be at greater risk of sustaining a fractured anterior tooth than were the sighted (O'Donnell, 1992).

The prevalence of traumatic injuries increased with age, which is in agreement with the results of previous studies among children with handicaps (Ohito et al., 1992; Denloye et al., 1996) and with normal children (Yagot et al., 1988). The increase in injuries with increasing age could also be because the children engage in more playful activities and games (Ohito et al., 1992). The 13 - 15 year-olds had the highest prevalence of traumatic injuries compared to younger age groups in an earlier study (Denloye et al., 1996). This may be the result of cumulative exposure to trauma in these age groups since in children damage to the hard dental tissues is permanent (Denloye et al., 1996). In an epidemiological study of children with handicaps, however, fractured incisors were found only in 5 - 8 year-olds with physical handicaps, while there was no significant association in 9 - 12 and 13 - 16 year-olds (Swallow, 1972).

Tooth fractures occurred more often in the maxillary teeth and central incisors, which is consistent with the findings of an earlier study on children with mental retardation (Denloye, 1996) and with other studies of normal children (Jamani & Fayyad, 1991; Zerman & Cavelleri, 1993; Kaste et al., 1996). These teeth are at greater risk of being traumatized because of their vulnerable position, frequent protrusion and inadequate lip coverage (Gutz, 1971; Nicholas, 1980). The majority of dental injuries in the anterior teeth, in particular are to the central incisors, which, being on the front of the face, are in the direction of body movement and tend to receive more trauma; and the early eruption exposes the central incisors to the risk of trauma for a longer period (Okpo, 1985). Children who are disabled and have protruding maxillary incisors are prone to repeated dental trauma. This is probably due to the fact that the upper teeth are generally anterior to the lower teeth and tend to be more readily affected by trauma. There is also an increased risk of traumatic injuries to the maxillary incisors due to the high frequency of extreme maxillary overjet in children with disabilities. Severe malocclusion (OR = 1.8) was a significant risk factor for the occurrence of traumatic injuries. Other important predisposing factors that contribute to a higher frequency of traumatic injuries to the anterior teeth include: Angle class II division I malocclusion, short or incompetent upper lip, and

accident proneness (Wei, 1988). There was no difference in injuries between the right and the left side of the maxilla. However, more injuries have been reported on the right side than on the left side (Garcia-Godoy, 1984) and vice versa (Zaragoza et al., 1998).

The type of disability was not a risk factor for occurrence of traumatic injuries. However, having a seizure disorder has been found to be a statistically significant predisposing factor in schoolchildren with mental retardation (Denloye, 1996). This has been attributed to the poor gait and seizure disorders seen in some of these disabled children. A large proportion of individuals with mental retardation sustain dental injuries; and this has been attributed to the associated epileptic seizures, which is an important predisposing factor in this group of individuals (Wei, 1988). Among a group of disabled children, more than half who were recorded as having had a fall were found to suffer from epilepsy (Ohito et al., 1992). Lack of concentration and control may also predispose children with mental retardation to injuries (Ohito et al., 1992).

There was no difference in the occurrence of traumatic injuries between the boys and girls. A greater proportion of boys than girls usually have injuries, which may reflect the greater degree of physical activity and contact sports engaged in by boys, who tend to play more aggressive games, than girls, who usually play passive games. A significant difference between boys and girls has been found in groups of physically and mentally handicapped, where boys had higher prevalence of injuries than girls did (Ohito et al., 1992). In one study on schoolchildren with mental retardation in Nigeria, a higher proportion of girls than boys were found to have fractured anterior teeth (Denloye, 1996).

Playing informal games is, however, part of growth and development and should be encouraged; but children should be warned about the dangers of predisposing themselves to injuries. Management of these children depends on prevention, as there are factors that may prevent the provision of good restorative care for them (Denloye, 1996).

Dental fluorosis (IV)

Among the disabled school population in Kuwait the prevalence of fluorosis was very low, even lower than among normal children. It was expected that the prevalence of fluorosis would have been higher among these groups with disabilities, as they have other associated developmental defects and abnormalities. However, the populations with disabilities in these

special needs schools have not been covered by the systematic programmes of oral health that cover normal children and have not been given fluoride supplements, which might be one reason for lower prevalence of fluorosis figures among the disabled. The finding, both in bivariate and multivariate analyses, that being of non-Kuwaiti nationality was a significant risk factor for the occurrence of fluorosis suggests that some non-Kuwaitis probably came from countries with areas of endemic fluorosis.

Because of the effect of increasing exposure to background fluoride in many parts of the world, it is of interest to monitor the occurrence of dental fluorosis continually in communities under different climatic conditions, especially as the prevalence and severity of dental fluorosis are known to be partly dependent on ambient temperature (Galagan & Vermillion, 1957). With the use of fluoride in preventive dentistry in the recent decades, dental fluorosis has become more widespread, even in areas with fluoride-deficient public water supplies (Burt, 1992; Wang et al., 1997). Fluoride in drinking water may prevent dental caries, but excessive ingestion during the period of tooth mineralization may also cause dental fluorosis (WHO, 1994). Dental fluorosis is a dose-response condition, so that higher intake during the critical period of tooth development will result in more severe fluorosis (Dean, 1942; Burt, 1992).

The stage of enamel development that is most vulnerable to excessive intake of fluoride is the transitional stage, which occurs between the late secretory and early maturation stages. The severity of dental fluorosis affecting an individual tooth has been attributed to the length of exposure to the body fluids during enamel formation (Thylstrup & Fejerskov, 1978). Teeth that have mineralised later in life generally show more severe fluoride disturbance than those that mineralised earlier (Burt, 1992). The primary teeth develop in a shorter time than the permanent teeth and are therefore less able to acquire fluoride (Ten Cate, 1985).

The widespread use of fluoride toothpaste is sometimes regarded as one of the major risk factors for an increase in the prevalence of dental fluorosis in areas with fluoride-deficient public water supplies. This is partly because children swallow a large amount of the toothpaste they use (Bentley et al., 1999; Zohouri & Rugg-Gunn, 2000). However, in this study toothbrushing frequency was not high, and therefore in this population fluorosis was not a serious risk.

Toothbrushing intervention programme among subjects with Down syndrome (VI)

The aim of this study was to examine if oral hygiene can be improved among subjects with Down syndrome and to develop a daily toothbrushing routine. The toothbrushing programme concentrated on encouragement of independent manual skills of the disabled subjects. With respect to oral hygiene, most of the disabled are very dependent. Moreover, it was shown that lower the level of dexterity, poorer the oral hygiene. Adequate oral cleansing is, in most individuals, heavily dependent on effective brushing. This may even be truer in the disabled, in whom natural cleansing by the oral musculature may be impaired (Shaw et al., 1989). In a study conducted in elderly long-term residents it was shown that dexterity tests correlated significantly with plaque scores (Felder et al., 1994). Although the present intervention was only short term, it demonstrated that disabled subjects can be instructed in simple oral hygiene procedures and that they can carry out toothbrushing procedures themselves when they are given encouragement and motivation. Although in some subjects cooperation was poor at the beginning, as the programme continued, there was a very noticeable improvement in cooperation as they became less apprehensive. This familiarization may be due to the continued daily help in toothbrushing by the teachers and the peer group influence. There seemed to be a very strong correlation between the plaque and gingivitis scores, both at baseline and in the final examinations. Although there was a consistent reduction in plaque and gingivitis scores, this correlation remained. This is a general finding in most clinical studies, confirming that plaque is the main determinant of gingivitis.

Brushing is a voluntary physical activity, and has two requirements: motivation and physical (manual) ability. Motivation, in turn, has two requirements: understanding of what is needed and of the reasons and benefits, and a desire to achieve those benefits. Educational research shows that simple incentives and reinforcement by professionals encourage young children to change their behaviour and maintain the change (Pine et al., 2000). Some retarded children are mentally incapable of understanding oral hygiene procedures, while others can understand them only with frequent reinforcement (Price, 1978). In general, there is a wide range of toothbrushing ability related to coordinated muscular movements, innate skills, ability to understand instruction and age of the individual (Unkel et al., 1995).

Children who are severely intellectually handicapped can be instructed in oral hygiene and can carry out toothbrushing procedures for themselves, if encouragement and motivation are given by schoolstaff (Shaw et al., 1983). Improvement of gingival health can be obtained by

instituting toothbrushing in special schools for the handicapped (Pool & Jaffe, 1976). Nielsen (1990b) stated that oral hygiene planning for the disabled (cerebral palsy) child could only be made when the child's oral hygiene has been evaluated individually and is controlled frequently. In a study of children with cerebral palsy, the highest gingival scores (5.2) were observed when the child and the parents together were responsible for the child's toothbrushing. When the parents brushed the child's teeth, the gingival index was 4.0, and when the children brushed without help it was 3.7 (Nielsen, 1990b). Previous studies have shown that children with learning difficulties can be taught toothbrushing, especially with the motivation of their teachers and with parental involvement (Reynolds & Block, 1974; Schwartz et al., 1978; Nicolaci & Tesini, 1982). The use of school dental nurses in a similar programme has also been described as being beneficial (Brown et al., 1980).

In a toothbrushing programme at school for children with moderate and severe learning difficulties (Lunn & Williams, 1990) and in tube-fed mentally handicapped patients (Dicks & Banning, 1991), supervised toothbrushing or care by staff has given encouraging results. A school-based toothbrushing programme for children with learning disabilities produced long-term improvements in oral hygiene as a result of enlisting staff support to help and encourage the children (Lunn & Williams, 1990). In a study by Nicolaci & Tesini (1982) steady improvement in oral hygiene was maintained for more than 18 months. In a supervised toothbrushing programme at school for non-institutionalized children with mental retardation with or without Down syndrome, the prevalence of severe gingivitis was lowest and better periodontal health was evident among those who had their teeth brushed every day under teacher supervision (Vigild, 1985a).

After treatment during an intervention programme, the number of sites affected by gingivitis and plaque was reduced markedly indicating that it is possible to institute a cheap and effective programme of oral health in schools (Ohito et al., 1993). In a study of 12 year-old disabled children in Belgium, the mildly mentally retarded and learning-impaired children had significantly better manual dexterity skills than did those who were moderately or severely mentally retarded or physically impaired. However, this was not reflected in improved oral hygiene (Martens et al., 2000). Although periodontal disease is a major health problem for the disabled, the institution of proper oral hygiene care has improved gingival health among this population (Goyings & Riekse, 1968). When assessed over a period of years, however, regular daily toothbrushing in patients with mental retardation does not always lead to long-term improvements in oral health (Ogasawara et al., 1990; Shaw & Shaw, 1991).

Toothbrushing can be taught in the same way as other skills, but it requires time for the individual as well as commitment on the part of the regular caregiver to ensure that all areas of the mouth are being cleaned each time. Toothbrushing often is not supervised or encouraged, and consequently, oral hygiene is poor, resulting in build up of plaque (O'Donnell & Crosswaite, 1988). However, many disabled children are intolerant of toothbrushing and may gag because of poor swallowing reflexes (Nunn, 1999). Although some schools for children with special educational needs provide toothbrushes for the children during their learning of personal hygiene skills, among the supervising staff awareness of the best method of mouth cleaning is often limited and is more dependent on their own perceptions of oral health and the perceived difficulty than on any other factor (Nunn, 1999). Children who are handicapped should use fluoridated dentifrices; but as with all young children, small amounts of dentifrice should be used, preferably under direct adult supervision (Chan & O'Donnell, 1996).

No electric toothbrushes were used in this study because of the large number of children. Electric brushes are more effective than manual ones and should be used when individuals can accept them (Warren et al., 2000). Even in groups with disabilities, thorough instruction and motivation in oral hygiene procedures may be of greater importance than the type of toothbrush used. Motivated children may improve their oral hygiene as effectively with a manual toothbrush as with an electric toothbrush. When the effects of manual and electric brushing are compared, both types of brushes are equally effective for use by the disabled (Shaw et al., 1983; Bratel et al., 1988); and for long-term oral hygiene effects, electric brushes are not better than normal brushes (Bratel & Berggren, 1991). In a study of children with physical disabilities, for removal of debris little difference was found in the efficacy of manual or electric brushes (Oldenburg, 1966). In a controlled clinical trial of manual and electric toothbrushing for the mentally subnormal, both types of brushes seemed equally effective, but the automatic brushes were preferred owing to their ease of handling (Swallow et al., 1969). An electric toothbrush could be of benefit to those children who have reduced manual dexterity but are capable of providing some of their own care (Doykos et al., 1967). For persons with severe handicapping conditions, an automatic toothbrushing device improved the patients' ability to control plaque (Fitchie et al., 1988).

Conventional toothbrushes were used in this study rather than modified ones. In some studies for improving the oral hygiene in children with cerebral palsy, individually modified toothbrushes appeared to be more effective than conventional ones (Soncini & Tsamtsouris, 1989; Damle & Bhavsar, 1995). Some other studies have shown no difference between

modified and conventional toothbrushes (Holcomb et al., 1979; Williams & Schuman, 1988; Spratley, 1991). However, some of the success of individually modified toothbrushes could be due to the enthusiasm of children for the ‘special’ toothbrushes, designed exclusively for their own needs (Damle & Bhavsar, 1995). No chemical intervention was used and active involvement of subjects was emphasized because a positive change in attitude toward proper oral hygiene habits was targeted. It would also have been more difficult for parents and teachers to accept chemical interventions.

There was some absenteeism in children in very small numbers during the toothbrushing program. Since we conducted the examinations during several days, exactly the same children present in the baseline assessments were also examined in the final assessments. Though it is essential that the parents be involved and motivated for the achievement of long-term benefits (Johnson & Albertson, 1972), parental participation was not possible since quite many of the children did not have parents. In addition, no control group was used in this study for ethical reasons, because the baseline assessment showed high need for improvement in oral hygiene among all the subjects in these two schools.

Over the long term, the toothbrushing programme is cost-effective; as it reduced number of visits of the dental team and is also likely to reduce the need for dental treatment. This toothbrushing study, which is still continuing, has shown that such a programme gives promising results, but the dramatic improvement has to be sustained.

Suggested strategies for improvement of oral health

Preventive measures

For many of these children with disabilities, dental care may not be perceived important by their parents or caregivers, yet dental disease or its consequences may pose further threats to these already compromised individuals. Hence the prevention of oral disease should be given high priority, and the principal aim should be oral health promotion and education for these vulnerable groups of the population. If dental health awareness and care are instituted early, complicated treatment needs requiring a special work force; facilities and effort can be kept to a minimum. The oral health status of these groups with disability should be improved by heightened awareness of the fundamental need for effective prevention from the earliest age through paediatricians, health visitors, and community and primary care teams (Nunn, 1996).

As preventive dental programmes are painless, require short-term cooperation between patient and dentist and carry less risk, they are more acceptable for patients with disabilities (Yilmaz et al., 1999).

Primary prevention approaches should be taught to the staff and to the caregivers and, when appropriate, to the individual patient. Since the major problem to be tackled is improvement of the oral hygiene of these children with disabilities, programmes that include oral hygiene in a child's individual plan should be encouraged. Emphasis should be placed on oral hygiene because it influences norms and behaviour (Fejerskov, 1995) and it is suggested that educational programmes of oral health intervention should be based on introduction of regular oral hygiene practices and use of fluoride toothpaste. Adequate follow-up of daily oral hygiene practice in children with disabilities is also required, and there is a strong need for in-service training programmes on oral hygiene. Hence, to be effective in the prevention of dental disease in these groups, oral hygiene must be strongly emphasized as a vital aspect of total health care and maintained on a daily basis.

To eliminate disabling dental diseases, preventive measures should be taken, mainly reduction in sugar intake, motivation of the staff to enforce oral hygiene and limitation of psycho pharmaceutical treatments. Greater emphasis needs to be placed upon the importance of maintaining the natural dentition in this population as long as possible. If the children's efforts are integrated with those of a motivated dentist, dental hygienist and staff, a well-planned programme of preventive dental health can lead to a high degree of success in the prevention of dental diseases in young populations. If dental health awareness and care are instituted early, complicated treatment needs requiring a special workforce, facilities, and effort can be kept to a minimum. Efforts to improve the oral health status of this group require continued attention. There is a need for greater efforts on the part of parents, dentists and other health care providers to improve the oral health of disabled children. It has been demonstrated that training care staff in basic oral health care procedures can help improve oral health (Sheiham, 1993; WHO, 1998). To maintain an effective oral health care routine, the dental hygienist or therapist has a major role to play in motivating, providing reassurance, support, specific advice and training for individual problems.

In this high-risk population, pit and fissure sealants should be applied to permanent teeth soon after eruption, as these measures are highly effective in preventing occlusal caries and parents should be advised of the need for regular monitoring and maintenance of fissure sealants

(Paediatric Dentistry, 1999). As children requiring special care are a priority group for the use of sealants, their use should be recommended on newly erupted permanent teeth. The current recommendations emphasize use of sealants for children with impairments because sealants are the most effective method of caries prevention (British Society of Paediatric Dentistry, 2000).

The benefits of fluoride for the prevention and control of dental caries is well documented (Paediatric Dentistry, 1999). Optimising fluoride in drinking water remains the cornerstone for prevention (American Board of Paediatric Dentistry, 1994); but in its absence, dietary fluoride supplements, fluoride toothpaste and topical applications are recommended (National Clinical Guidelines, 1997; Paediatric Dentistry, 1999). Use of fluoride toothpaste would help to reduce caries risk, and the routine use of these regular behaviours might keep children aware of oral health care. These factors are much more important for oral health in Kuwait where fluoridation of drinking water has been discontinued. Community-based alternatives, such as salt fluoridation and school-water fluoridation, should be considered. Milk fluoridation could also be an alternative. Fluoridation of water supplies should be reconsidered as there is a piped water supply, and it is cheap and does not depend on individual action.

For professional use, fluoride varnishes are the safest and most practical method for the patient (Seppa, 1991; Beltran-Aguilar et al., 2000), hence their use should be recommended for these special schools. The amount of ingested fluoride has been shown to be much less with fluoride varnish therapy than with applications of fluoride gel, and twice a year applications have been shown to reduce caries increment by 50% (U.S. Department of Health and Human Services, 2001). Fluoride varnish is an almost ideal preventive dental agent for children with poor tolerance to dental procedures (Nunn, 1999).

In a recent study, xylitol lozenges were shown to reduce caries reduction as successfully as xylitol chewing gum (Alanen et al., 2000). Those disabled children who can control their swallowing reflexes well could use these very easily. Currently the xylitol candy programme is being tested in schools for children with physical disabilities.

Education and implementation of oral health practices are especially important in preventing dental diseases in disabled children who are living at home. The best means of establishing good oral hygiene in the disabled is not only through the increased efforts and expertise of dental professionals, but also through systematic instruction in self care skills for oral hygiene. There is a strong need for programmes of oral hygiene instruction for educators, parents and dentists involved in the special care of these groups. There is a real need for in-service training

programmes for educators as well as for parents. To reduce the proportion of disabled children with poor oral hygiene and gingival problems, greater resources should be allocated. Continuous prophylactic care for this group can be achieved when specially trained personnel such as dental hygienists work in these centres.

Oral health education

All programmes of oral health promotion for children with disabilities should have specific, measurable, appropriate, realistic and time-related objectives. The objectives should include policy development, improved availability of healthy choices, improvements in oral hygiene skill and provision of services (British Society for Disability and Oral Health, 2001). As education and training in oral health care on an individual basis is known to be effective, oral hygiene programmes should include supervised toothbrushing sessions.

To enable prevention, early detection and treatment of dental caries along with maintenance of periodontal health, oral health promotion should include facilitating access and regular use of oral health services. Messages promoting oral health should fit into the overall context of good general health including physical, mental and social well-being.

Dietary advice for children with disabilities should be made within the context of healthy eating policies. It is important to provide simple, practical and realistic guidance for selecting a balanced diet (Nutritional Task Force, 1994). When high caloric intake is recommended to maintain nutritional status, intensive preventive techniques for dental health are recommended. Thus, collaboration between dentists and dieticians will ensure that appropriate preventive advice is offered. General medical practitioners should be made aware of the oral health risks of long-term sugar-based medication and, when possible, prescribe sugar-free alternatives. Information about adequate dietary habits should be given in particular, information on the risk of frequent consumption of sugars and sweets. As these children are at high risk for dental caries, it is recommended that, along with dietary counselling with limited achievable targets and regular monitoring of compliance, a food diary be kept. The Nutritional Task Force (1994) emphasises the importance of providing simple, practical and realistic guidance for selecting a balanced diet. In the context of healthy eating policies, the use of vending machines should be discouraged by health education campaigns. Information about adequate dietary habits should be given, in particular, information on the risk of frequent consumption of sugars and sweets.

Due to the complication of their disability and the cumulative nature of oral disease, regular and consistent oral health care is more important for these children than for normal schoolchildren. Both improved accessibility to dental services and dental health education are necessary to ensure that optimum dental health is within the reach of these children.

Intervention programmes in dental health education should be given high priority and should focus on assessing the effectiveness of various kinds of educational intervention programmes.

Access to oral health services needs to be improved. All preventive activities should have an educational component, and an oral health assessment should be included as part of general health assessment. From an early stage the children with handicaps, their parents and care workers require dental health education and active involvement in programmes of prevention. Because all preventive measures should be provided at an early age, dental health education should also target expectant mothers.

Orthodontic treatment for children with disabilities has long been neglected, and this treatment need should be taken into account in future planning of oral health care (Ackerman & Wiltshire, 1994). Preventive measures with regard to trauma to the face, jaw and teeth need to be included in the school curricula and disseminated to children during lessons involving health activities (Ohito et al., 1992). In general, traumatic dental injuries are preventable and preventive measures can be applied (Wei, 1988). Because many dental injuries can be avoided, prevention is extremely important. Athletic mouth guards, when they can be tolerated, significantly decrease the risk of dental injuries in children participating in contact sports and in those with developmental disabilities who are at high risk for falls or self-injury (Andreasen & Andreasen, 1994). A custom-made mouth protector could also be used to assist handicapped subjects who cannot use their hands to perform many functions (Blaine & Nelson, 1973). Early and consistent preventive, reparative, orthodontic, and trauma protection care is needed.

School oral health services

Educational institutions should include oral health as part of training or socialisation programmes. Continuing education of the dental personnel so that they acquire additional training and management skills is an essential component in providing valuable services for groups with special needs. The process of improving the oral hygiene of children with disabilities requires an integrated approach involving the child, the parent or the caregiver and the dental personnel. In-service training in promotion of good oral health for children with

disabilities and in how to access oral care ought to be provided for teachers, institutional staff and parents (Martens et al., 2000). Due to the fact that the disabled population is increasing dramatically, advanced programmes of continuing education are needed for both general and paediatric practitioners (Nunn & Murray, 1987; Waldman, 1991; Boj & Davila, 1995; Glassman et al., 1996). Emphasis must be placed on planning and implementing innovative programs for the prevention of periodontal disease. In addition, all training in professional dental health care should include care of disabled patients.

Positive links between educational establishments and dental services are essential for promoting the oral health of children with disabilities. To enhance oral health outcomes, advanced training is recommended for dental providers and the staffs of schools. More effort from the community dental service and the school staff will be required to promote oral hygiene programmes in these schools. The oral health care for disabled children can be improved by more effective assistance and increased awareness of dental health concerns by caregivers. The dental profession has a special responsibility to raise the awareness of parents concerning the need for early and regular contact with dental services for children with disabilities and also to acquaint them with the range of other health-care professionals available for the child.

A majority of the disabled children in this study were in need of specific dental care. These substantial unmet dental needs should prompt efforts by the dental profession to facilitate health care for individuals with disabilities and to seek ways to increase access to dental services. The oral health status of this disabled school population is largely dependent on the ability of the dental services to provide treatment to at least the same level as for normal children. Cooperation of children is an important factor when providing dental treatment (MacLaurin et al., 1986). Dental providers should develop priority-based treatment plans and utilize more effective restorative and periodontal therapies. Professionals should collaborate to identify children with disabilities and refer them to the appropriate oral health care services for integrated care. Patients needing treatment under general anaesthesia or intravenous sedation should be referred to appropriate treatment centres. The rationale and protocol for appropriate use of restraints and chemo sedation should be understood. There is a significant need to train dentists in the management of individuals with disabilities. Training dentists and dental auxiliaries in the understanding and the management of patients with disabilities, the availability of additional preventive measures, including occlusal sealants and use of topical fluorides, should assist in creating a normal and productive life for individuals with disabilities.

Conclusions

1. The oral health in this disabled school population is poor, and a majority of the children in the study are in need of specific dental care.
2. The caries experience among this school population with disabilities is clearly higher than among the respective age groups of normal schoolchildren. Caries experience is highest in subjects with Down syndrome and lowest in the blind.
3. The levels of oral hygiene are significantly poorer and the prevalence of periodontal disease is greater than among normal children. The type of impairment was significantly associated with the periodontal problems observed; those subjects with Down syndrome have the poorest levels of oral hygiene and the greatest need for periodontal treatment.
4. Malocclusion and traumatic injuries are more prevalent among these subjects with disabilities than among the healthy population.
5. Dental fluorosis is less prevalent among these subjects than had been reported among the healthy population.
6. The two-year caries incidence and increment of subjects with Down syndrome is higher than in the recent national survey of children without disabilities.
7. The 3-month supervised toothbrushing programme seems to be effective in reducing plaque and gingivitis scores in subjects with Down syndrome.
8. The results show a pressing need for preventive dental care services for this disabled school population; this situation must be improved and a suitable system devised for delivery of preventive measures.
9. The marked differences in the oral health of these children compared to normal children further emphasise the need for disabled children to receive regular dental attention. Due to the complications resulting from their disability and the cumulative nature of dental disease, regular and consistent dental health care is more important for these children than for normal children.
10. The findings in this study spotlight the lack of dental treatment for this group. Dental care for the handicapped is insufficient. The oral health status of subjects with

disabilities differs from that of normal children. Disparity in oral health status also exists among groups with different disabilities.

11. The higher levels of dental disease in the disabled seems to be due to poor utilization of dental services and lack of dental awareness. These substantial unmet dental needs should prompt efforts by the dental profession to facilitate health care for individuals with disabilities and to seek ways to increase their access to dental services.
12. The oral health status of this disabled school population is largely dependent on the ability of the dental services to provide treatment up to at least the same level as for normal children.
13. There is a distinct need for strengthening organised preventive and curative programmes for this disabled school population in Kuwait. These results are in accordance with other similar studies worldwide.

Recommendations

1. The oral health situation of these groups must be improved and a suitable system devised for delivery of preventive measures. Special consideration must be given to improving the oral health of these groups. Oral health should be included in each child's individual health care plan. Oral health promotion programmes should be aimed specifically at special needs schools and their parents. Young children and their parents should be targeted for oral health promotion interventions and early dental attendance.
2. The key to good oral health is the involvement of parents in early implementation of preventive practices, including good dietary habits, appropriate fluoride therapy, fissure sealants and effective oral hygiene.
3. To improve oral hygiene status and gingival condition and to increase the percentage of teeth treated for dental caries, a scheduled and active practice is necessary. There is a need to establish oral hygiene programmes; and in particular, all these groups should be educated in how to maintain proper oral hygiene and should receive the benefits of topical and systemic fluoride. Programmes that include oral hygiene in the child's individual educational plan should be encouraged.
4. Programmes of caries prevention must be implemented for these high-risk children. Children at risk of dental caries should have fissure sealants applied to all permanent

molars soon after their eruption. The use of fissure sealants should be emphasized, since children requiring special care are a priority group for use of fissure sealants. Sealant programmes should be encouraged as a means of preventing fissure caries. Special mobile dental units could be used to improve the coverage of the sealant program in these schools and parents could be advised of the need for regular monitoring and maintenance of fissure sealants.

5. Regular school-based programmes of toothbrushing should be implemented and reinforced in all these groups with disabilities. Children should be instructed to clean their teeth twice a day and oral hygiene should be practised at school and supervised by teachers. The use of fluoride toothpastes should be recommended as a routine part of self-care.
6. Re-introduction of the water fluoridation programme, discontinued since 1980, should be reconsidered. Water fluoridation, which was shown to be particularly important for children attending special schools, had a greater affect on caries prevalence than social background did. Supervised programmes of fluoride supplementation should be reinforced in these schools, and the use of topical fluoride varnishes should be recommended.
7. The intake of sugary drinks and snacks in the diet should be limited to mealtimes, and healthy snacks should be encouraged as an alternative. Healthy eating policies should be promoted in these schools. Public policy for controlling the availability of highly cariogenic foods should be considered.
8. There is a clear need to involve the dental profession more actively in dietary counselling and provision of preventive oral health care and treatment.
9. The Ministry of Health should provide in-service training for teachers, school staff and parents on how to promote good oral health specifically for these children with disabilities.
10. Oral care should be an integral part of social care planning and should be included in national, local and residence-based disability strategies.
11. Different programmes of intervention should be included in a prospective study in order to compare them and determine which would be more effective.

7. SUMMARY

As a result of growing concern about the oral health of subjects with disabilities in Kuwait, the aim of this epidemiological dental study was to investigate the oral health status and treatment needs of this population and to plan preventive interventions and a programme of oral health promotion for this high-risk population. The study was designed to identify base-line needs with the intention of prompting improvements in oral health status for this population. The specific objectives were: 1) to obtain base-line data, assess the caries experience and determine the treatment need in subjects with various disabilities who are attending the special needs schools, 2) to determine the levels of oral hygiene and periodontal health, 3) to determine the prevalence of malocclusion and traumatized anterior teeth, 4) to determine the prevalence of dental fluorosis, 5) to determine the incidence of dental caries in subjects with Down syndrome, and 6) to test whether the oral hygiene can be improved by a programme of supervised toothbrushing and oral health education in a group of subjects with Down syndrome.

The study population comprised 832 children and young adults (3 - 29 years; mean age 12.1 years) with visual, hearing, physical or developmental disabilities who are attending special needs schools. Data were recorded according to the criteria described by WHO (WHO, 1997b). Data for each subject were recorded on a modified form of the standard WHO oral health survey. Dental caries was scored by surface on all erupted teeth in accordance with the WHO criteria. Sealants were detected by the visual-tactile method. Oral hygiene status was recorded using the special plaque index of James et al. (1960). Oral hygiene habits consisted of toothbrushing frequency and provision of help with toothbrushing. Periodontal condition and needs were assessed by the Community Periodontal Index of Treatment Needs (CPITN). Malocclusion was identified in accordance with WHO criteria. All tooth surfaces with a crown fracture were given a score of T. Dental fluorosis was scored according to Dean's classification. In the toothbrushing intervention study, plaque was scored according to the Silness & Loe plaque index and gingivitis according to the Loe & Silness gingival index.

The mean dmft was 5.6 and the dmfs 15.1, being highest in subjects with Down syndrome and lowest in the blind. The mean DMFT was 5.9 and the mean DMFS 13.3, being highest in those with Down syndrome and lowest in the blind. Increasing age, impaired hearing and poor oral hygiene were significantly associated with caries risk. Evaluation of oral cleanliness showed poor hygiene in 38% of the subjects. The proportion of children with good oral hygiene was

highest among the blind and lowest among subjects with Down syndrome. For all subjects, 87% brushed their teeth at least daily; and of those who brushed, 72% received no help with brushing. The subjects with Down syndrome had the highest proportion of pockets, 60%; one-third of them had deep pockets; the hearing impaired group had the lowest proportion of pockets, 21%. Poor oral hygiene was strongly associated with periodontal disease. Prevalence of severe malocclusion was 23.6%; this proportion was highest in subjects with Down syndrome, where 36.6% had severe malocclusion and lowest in the blind group, 7.7%. Down syndrome, increasing age and male gender gave the highest risk for occurrence of severe malocclusion. Less than one-fifth of the subjects (16.9%) had traumatized anterior teeth. However, severe malocclusion and increasing age were significant risk factors for the occurrence of traumatic injuries. None of the subjects had severe fluorosis; less than 1.0% showed moderate fluorosis; 0.7% had mild fluorosis, 2.5% had very mild fluorosis and 5.8% had questionable fluorosis. The occurrence of dental fluorosis was higher among Kuwaitis than among non-Kuwaitis.

For the incidence study, the target population included all subjects with Down syndrome and moderate mental retardation with permanent dentition ($n = 102$) who were attending these special needs schools in 1999 (9 - 19 years; mean age = 12.6 years) and in 2001 (11 - 21 years; mean age = 14.9 years). The caries incidence (% of new subjects affected with caries between 1999 and 2001) was 10.3%, while the proportion of caries-free subjects ($DMFS = 0$) decreased from 17.6% in 1999 to 7.3% in 2001. During the same period, the caries increment ($DMFT$) was 3.0. The mean $DMFS$ increased from 10.2 to 16.5, indicating a mean increment of 6.3 caries-affected surfaces during this 2-year period. The two-year caries incidence and the increment of these subjects were clearly higher than a recent national survey of children without disabilities.

In the toothbrushing study, 112 Down syndrome subjects with an age range of 11 - 22 years (mean age = 14.9) participated in the intervention programme. During the 3-month period, the plaque and gingivitis scores decreased significantly, the mean plaque score decreased from 1.93 to 0.95 and the mean gingival score from 2.00 to 0.83. In all age groups, the reduction of plaque and gingivitis scores was significant. There was high correlation between the individual plaque and gingivitis scores at the baseline examinations ($r = 0.83$) and between the plaque and gingivitis scores at the final examinations ($r = 0.91$). Although this programme of supervised toothbrushing, which is still continuing, gave promising results and was effective in reducing the plaque and gingivitis scores, the key to long-term success of the programme is to

maintain the subjects' motivation to make oral hygiene a part of their daily routine and thus sustain this improvement.

This study has highlighted important differences in oral health and treatment needs in the disabled school population compared with normal schoolchildren. It has shown that poor oral health is a major problem for disabled schoolchildren and that the oral health of the disabled children assessed seemed to indicate a cumulative neglect of oral health. The lack of regular dental care, which is available to normal schoolchildren, was reflected in the dental status of the disabled when their oral health was compared with that of normal schoolchildren. Because disabled children are recognised as a high-risk group for dental disease, they should also receive more preventive dental treatment. This study confirmed the need for strengthening organised preventive and restorative care for this population in Kuwait.

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APPENDICES 1-5

Appendix 1. Summary of studies on caries experience among the disabled.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Boyd & Cheyne, 1947	Institutionalized (Instit) mentally retarded (MR)	124	6-19	DMFS	Caries experience (CE) lower than in the general population.
Johnson et al., 1960, USA	Instit Down syndrome (DS) children and non-DS children with congenital mental defects	212	9-10	dt, ft, DT, FT	DS children had much lower caries level than the matched group of non-DS children.
Siegal, 1960	Non-instit Cerebral Palsy (CP)	65	2-12	DMF	CE similar to healthy children.
Snyder et al., 1960, USA	Non-instit MR	113	1-19	def, DMF	CE lower than in healthy children. Very low level of restorative care among retarded children.
Tannenbaum & Miller, 1960, USA	Instit MR	38	12-22 (mean = 15.0)	DMFT	CE lower than in the general population.
Brown & Cunningham, 1961	Instit DS	80	1.5 -35		CE lower than in the normal population. 53% were caries-free.
Shmarak & Bernstein, 1961	Non-instit CP and Instit CP	81	3-15	DMF	CE higher than in healthy children.
Winer & Cohen, 1962	Instit DS children and non-DS children	196	Mean = 4.9	DFT, DFS	DS children had less CE than non-DS children.
Magnusson & de Val, 1963	Non-instit CP and Instit CP	76	3.5-18	DMF	CE higher than in healthy children.
Cohen & Winer, 1965	Instit DS and non-DS	226	3-30	DFS	CE lower in children with DS than in non-DS.
Creighton & Wells, 1966, USA	Instit DS and non-instit DS	796	7-20	DMFT	CE lower in DS than in other mentally retarded children.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Smith et al., 1966, USA	Instit MR	400	3-7.5	deft, DMFT	CE lower than in the general population.
Butts, 1967, USA	Instit MR and non-instit MR	1886	6-20	dft, DMFT	Both MR groups, regardless of the degree of retardation, had lower CE than normal comparisons.
Fishman et al., 1967, USA	CP and non-CP siblings	203 335	4-18	def, DMF	No difference in CE between the groups. Significantly greater number of missing teeth in CP group.
Steinberg & Zimmerman, 1967, USA	Instit mentally deficient, MR	568	10-21	DMFT	Lower CE in mentally deficient than in MR group.
Wolf, 1967, USA	Instit DS and non-DS	100 100	2-5.3	DFT, DFS	CE lower in DS. More caries-free individuals in DS.
Swallow, 1968,	Non-instit CP	298	5-16	DMF	CE the same as in healthy children.
Gullikson, 1969, USA	MR and non-Instit DS	201	3-14 (mean = 7.4)	DMF	CE higher than in healthy children.
Kroll et al., 1970, USA	Instit & non-instit DS and non-DS	149 159	5-25	DMFT	No difference in CE between groups. More caries-free children in DS than in non-DS.
Miller & Taylor, 1970, USA	Orthopedically handicapped children	411	Not specified	DMFT	Handicapped had significantly higher CE than normal children.
Cutress, 1971a, New Zealand	Instit & non-instit MR and DS Control: Normal	848 697	5-24	DMFT, DMFS	CE lower in DS individuals than in the other groups.
Pollack & Shapiro, 1971, USA	MR (mild, moderate, severe)	263	14-22	DF	CE higher in severely MR individuals than in healthy ones.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Rosenstein et al., 1971, USA	Non-instit MR occup day centers (DS, mentally deficient)	72	17-43 (mean = 25.1)	DMF	CE was moderate but higher than reported for other groups of retardates.
Swallow, 1972, Israel	Educ subnormal; Physically handicapped Control: Normal	1584	5-16	deft, DMFT	DMF similar in all groups studied.
Gullikson, 1973, USA	DS children & non-DS and MR	472	5-16	deft, DMFT	No difference in CE.
Murray & McLeod, 1973, UK	Non- instit severely subnormal (IQ 20 to 50)	343	2-16	dmft, DMFT	High proportion of carious lesions untreated; 62% were caries-free (CE=1.0) in 6 to 9- year-olds, and 45% (7.1) in 13 to 16- year olds.
Orner, 1975, USA	DS children Unaffected siblings	212 124	5-20	DMFT	CE lower in DS than in their siblings.
Sandler et al., 1975, USA	Instit MR and non-Instit MR	137	1-30	DMF	CE higher in outpatients than in inpatients.
Svatun & Heloe, 1975, Norway	Instit mentally subnormal	353	5-45	DMFT	CE lower than in general population. Every second needed some conservation, and every tenth extraction.
Greeley et al., 1976, USA	Blind students Partially sighted and totally blind	120	11-23	DMFT	CE did not differ from normal children.
Steinberg & Zimmerman, 1978, USA	Institutionalized persons with various mental disorders	250	10-21	DMFT, DMFS (3-year increment)	Only small differences in caries increments.
Mehrotra et al., 1982, India	Mentally and physically handicapped	127	8-55	Caries prevalence	Caries prevalence higher in MR individuals than in physically handicapped.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Naoh, 1982, UK	Mentally and physically handicapped	98	5, 15 yr-olds	dmf, DMF	CE similar to that of normal children; high proportion of carious lesions untreated.
Palin-Palokas et al., 1982, Finland	MR children Healthy	58 58	9-10	DFS	CE similar to that of healthy children. Higher prevalence of untreated caries lesions in MR children than in healthy children. Mildly or moderately retarded had highest CE.
Latner, 1983, USA	DS children	122	3-8	ds, DS	No differences in CE between the three chromosomal types of DS.
Nowak, 1984, USA	Non-instit CP, DS and MR	3622	0-16 and older	DMFT	CE the same as in the normal population. Mean (MT) higher than mean (DT) and (FT).
Forsberg et al., 1985, Sweden	Severe MR, DS (instit & non-instit)	100	3-17	DMF	CE was similar in non-instit and healthy children, but lower in instit children.
Girgis, 1985, Canada	Severe mental, physical and other conditions	1094	5-45 and older	DT, FT	Low CE observed. Mean DT was 0.40 and the mean FT 3.01.
MacLaurin et al., 1985a, UK	Different disability conditions Normal	3218 1344	2-19 4-16	DMF	CE similar to normal. No difference in CE between groups, but the handicapped had received less restorative treatment.
MacLaurin et al., 1985c, UK	DS and other mentally handicapping conditions Normal	1720 1344	3-19 4-16	dmft, dmfs, DMFT, DMFS	DS individuals had significantly less CE in the primary dentition, but no difference in the permanent dentitions.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Nagaraja Rao, 1985, India	Socially handicapped certified schoolchildren	411	5-14	df, DMF	Almost 50% of children affected by dental caries.
Storhaug, 1985, Norway	10 different disabling conditions	436	1-6	dmft	CE higher than in normal children of corresponding age. Children with congenital heart disease, asthma and cystic fibrosis had higher CE than the other groups.
Barnett et al., 1986, USA	DS patients MR controls	30 30	< 15 - \geq 35	Caries Prevalence	DS patients had lower prevalence, especially on the proximal lesions, than the controls.
Holland & O'Mullane, 1986, Ireland	Instit handicapped	194	3-50	DMFT	High CE and treatment need. Need for extractions and complicated restorations highest in the oldest patients.
Jones & Blinkhorn, 1986, UK	MR children	340	5, 12 and 15 yr-olds	d, m, f, dmft D, M, F, DMF	12- and 15-year-old children had less restorative treatment than normal children.
Lizaire et al., 1986, Canada	Different disability conditions	1046	4-26	deft, DMFT	CE higher and level of restorative care lower than among normal children.
Mann et al., 1986, Israel	Instit physically handicapped	43	3-22	def, DMF	Strong correlation between caries and oral hygiene levels. Low level of restorative care.
Pieper et al., 1986, Germany	Mentally subnormal	199	17-64	DMFT	High CE and treatment need.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Shaw et al., 1986, UK	Different types of handicapping conditions Normal	3562 1344	5-15	dmft, DMFT	CE higher than in healthy children. Less restorative treatment than normal. No difference in CE between children with different handicapping conditions.
Vigild, 1986, Denmark	Insttit and non-insttit MR with DS	288	6-19	DMFT, DMFS	Insttit children had lower CE than those living at home.
Nunn & Murray, 1987, UK	Different disability conditions	1730	2-19	dmf, DT, MT, DMF	CE higher than normal children. CE was similar in different handicaps.
Palin-Palokas et al., 1987, Finland	MR children Healthy	125 79	9-10	DFS	Poor standard of oral hygiene and frequent use of sugar-sweetened snacks were risk factors for caries in both retarded and healthy children.
Storhaug & Holst, 1987, Norway	10 different disabling conditions	415	1-6	DMFT	Children with juvenile rheumatoid arthritis, epilepsy and cystic fibrosis had higher CE than the other diagnostic groups. Age, mother's education; everyday life factors and diagnosis had the strongest association with CE.
Costello, 1990, Ireland	Mentally and physically handicapped children	171	4-16	dmft, DMFT	CE similar to that of normal children. Untreated decay higher than in normal children.
Nielsen, 1990a, Denmark	CP children	105	14-15	DMFS	CE lower than in normal children. Untreated decay and number of missing teeth higher than in normal children.
Evans et al., 1991, UK	Different disability conditions	677	3-19	dmft, DMFT	Five-year-old children had dmft of 4.18, which was significantly higher than normal, but CE of 12- and 14-year-olds was lower than in other state schools.
Francis et al., 1991, UK	Slightly, moderately and severely impaired young handicapped adults	195	25-34	DMFT	Untreated decay higher than normal.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Gugushe, 1991, South Africa	Instit handicapped high school pupils: Physical, visual and aural	267	14-23 (mean = 18.0)	DMFT	No difference in CE between the three handicapped groups or between boys and girls. High proportion of untreated decay.
Pope & Curzon, 1991, UK	CP children Normal	150 191	Mean = 10.3 Mean = 10.4	DMF	CE similar to normal controls. Number of unrestored and missing teeth higher than in normal controls.
Stabholz et al., 1991a, Israel	Instit DS children Control group I-healthy children Control group II-Non-DS mentally retarded	32 30 19	8-13	def-s, DMF-S	CE, as indicated by decayed, missing, and filled surfaces, lower in DS group than in either control.
Vignesha et al., 1991, Singapore	Different disability conditions	322	6-18	DMF	CE higher in disabled than in normal children. No differences in CE among the disability groups. Decayed component greater than the missed or filled component.
Vyas & Damle, 1991, India	Different disability conditions Normal	260 206	11-14	DMFS	Prevalence of caries higher in normal children (84.9%, DMFS 6.19) followed by juvenile delinquents (75.7%, DMFS 4.3), physically handicapped (73.9%, DMFS 4.3) and mentally subnormal (64.9%, DMFS 4.5).
Gupta et al., 1993, India	Different types of handicapping conditions	1042	3-14	deft, DMFT	CE higher than in normal children. CE highest in MR children and lowest in the deaf and mute. Higher deft and DMFT recorded in mandibular teeth compared to maxillary teeth.
Nunn et al., 1993, UK	Physically handicapped children	129	3-17 (mean = 10.7)	dft/dfs DMFT /DMFS	dft/DMFT were 0.9 and 2.0. dfs/DMFS 2.5 and 3.4. CE higher in girls than in boys.
Ohito et al., 1993, Kenya	Different disability conditions	449	5-15	DMFT	CE was high. Caries found in 44% of children with a mean DMFT of 0.8. CE was highest in children with combined physical and mental handicaps and lowest in those with speech defects.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Bhavsar & Damle, 1995, India	Different disability conditions	593	12-14	DMF	CE was high, highest in CP children and lowest in the blind. D was higher than M and F components.
Morinushi et al., 1995, Japan	DS children	75	2-18	Caries-free%, dmft	CE lower than in normal children. The caries-free proportions were higher than in normal children.
Gizani et al., 1997, Belgium	MR and learning impairment	626	12 yr-olds	DMFT, DMFS	DMFT and DMFS scores were 2.9 and 5.4; 21% of the children were caries free. No differences between groups. Low level of restorative care. CE of the first permanent molars was the largest part of the DMFT score (64.1%). Sealants in 7.9% of the children.
Shapira et al., 1998, Israel	MR children and adults [Four levels of MR]	387	3-41+	DMFT	Age-adjusted DMFT was 12.8. MT was higher in the educable group than in those with mental retardation and severe physical handicap.
White et al., 1998, USA	Mentally disabled Special Olympic athletes	385	9-49	DT, MT, FT,	Child athletes (9 to 20 years) had more untreated decay and more MT than 9 to 20-year-olds in the general American population.
Yarat et al., 1999, Turkey	DS Healthy	26 25	6-24	dmft-t, dmft-s, DMFT-T, DMFT-S	CE similar to healthy controls.
Mitsea et al., 2001, Greece	Children and adolescents with CP, MR and visual disorders	170	6-15	Defit, DMFT	Treatment need was extremely high in all groups. Children with vision problems had lowest treatment needs. CE was highest in MR children and lowest in children with vision problems.
Bian et al., 2001, China	Children with cleft lip and cleft lip/palate	104	3-6	dt, mt, ft, dmft	CE was higher in children with cleft lip/palate compared to those with only cleft lip.
Seymen et al., 2002, Turkey	DS children Controls: healthy	48 48	3-15	dft, dfs, DMFT, DMFS	CE similar to healthy children.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
O' Donnell et al., 2002, Hong Kong	Mental and physical disabilities	748	4, 14, 25 - 35 yr-olds	dmft, DMFT	CE of 14-yr-olds higher than normal children. The missing component was high in all the age groups. There was no correlation between caries experience and physical mobility, mental impairment, or sex in any age group.
Gunn et al., 2003, UK	Moderate learning disability	128	7-18	dt, dft, DT, DMFT	A high level of untreated decay was noted in the primary and permanent dentition.
McAlister & Bradley, 2003, Ireland	Different disability conditions	704	3-17	dmft, DMFT	The mean dmft of 5-year-olds was higher than normal children. The mean DMFT of 8-, 12- and 15-year-olds was lower than normal children.

Appendix 2. Summary of studies on oral hygiene and periodontal conditions among the disabled.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Weisman, 1956	CP children	253	Not specified	PMA Index	Prevalence of gingival and periodontal diseases was 80%, which was three times higher than in normal children.
Tannenbaum & Miller, 1960, USA	Instit MR	38	12-22 (mean = 15.9)	Clinical classification	74% of instit MR children had acute or chronic gingivitis.
Snyder et al., 1960, USA	Non- instit MR	113	1-19 (mean = 9.4)	Clinical classification	66% had recordable periodontal disease.
Brown & Cunningham, 1961	Instit DS	80	1.5 –35		90% had periodontal disease. 36% of children under 6 years had pocket formation. Advanced periodontitis was present in 59%.
Cohen et al., 1961	DS, MR	100	1-30		96% affected with periodontal disease in DS individuals compared to 40% in MR individuals. All DS individuals had periodontal involvement. High degree of periodontal disease noted in DS individuals.
McMillan & Kashgarian, 1961	Instit DS	174	Upto 40		Gingivitis was severe in DS individuals and progressed with age. Severity of periodontal disease in DS individuals was twice that seen in other congenital mental defectives.
Johnson & Young, 1963, USA	Instit DS and non-DS; congenital mental defectives	110	9-30	Russell's Periodontal Index (RPI)	Greater prevalence of gingivitis than in normal individuals.
Magnusson & de Val, 1963	CP outpatients and inpatients	76	3.5-18		PMA in non -DS group was higher than in DS group. RPI scores higher in DS group. Poor oral hygiene and high prevalence of periodontal disease.
Cohen & Winer, 1965	Instit DS and non-DS	226	3-30	Modified PMA RPI	
Smith et al., 1966, USA	Instit MR	400	3-75	RPI	

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Butts, 1967, USA	Instit and non-instit MR	1886	6-20	Oral Hygiene Index (OHI) RPI	Poorer oral hygiene and greater periodontal disease in mental retardates than in normal subjects.
Fishman, 1967, USA	Non-instit CP Non-CP siblings	203 335	4-18	OHI-S RPI	Poorer oral hygiene and higher RPI scores in CP children than in siblings.
Goyings & Rieske, 1968	Instit DS and non DS	88	5-19 (mean = 9.0)	0=no gingivitis 1=marginal gingivitis 2= gingivitis with ulceration 3=gingivitis with pockets 4=combination of 2 and 3	More severe periodontal disease in DS children than in non-DS children.
Swallow, 1968	Non-instit CP	298	5-16		Gingivitis similar to normal control.
Gullikson, 1969, USA	MR and non-instit DS	201	3-14 (mean = 7.4)	Marginal gingivitis classified	35% had active gingivitis.
Kroll et al., 1970, USA	Instit and non-instit DS Non-DS children	149 159	5-25	Criteria for periodontal disease: Abnormal tissue loss noted by radiographic or clinical findings 1-no loss 2-notable loss 3-severe loss Unspecified PI	Prevalence of periodontal disease was higher in DS individuals than in non-DS individuals.
Miller & Taylor, 1970, USA	Orthopedically handicapped children	411	Not specified		Higher PI than in normal children. The arthritis group had higher PI than other groups.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Cutress, 1971b, New Zealand	Instit & non-instit MR and DS Normal	480 464	10-24	RPI	Instit DS individuals had higher RPI scores than non-instit DS, instit and non-instit MR individuals.
Rosenstein et al., 1971, USA	Non-instit mental retardates attending occup day centers (DS, mentally deficient)	72	17-43 (mean = 25.1)	Oral hygiene: (clean, moderate, poor) Gingival & periodontal involvement: PMA index	Poor oral hygiene. Poorest oral hygiene in lowest IQ. DS individuals had more severe gingival and periodontal disease than non-DS individuals.
Swallow, 1972, Israel	Physical handicap, medical handicap, educationally subnormal Normal	2112 472	5-16	Gingivitis classified into: (mild, severe, hypertrophic)	Educationally subnormal group had the poorest oral hygiene and gingival status.
Gullikson, 1973, USA	DS, non-DS and MR children	202	3-10	Health of the gingiva determined by clinical judgement.	Gingivitis more prevalent among DS children than among non-DS MR children.
Murray & McLeod, 1973, UK	MR & severely subnormal non-instit children (IQ 20 to 50)	343	2-16	James (Dental cleanliness & Gingival index)	Oral hygiene and gingival health poorer than in normal children. Oral hygiene and gingival condition deteriorated with increasing age.
Sandler et al., 1975	Instit and non-Instit MR	137	1-30	RPI	RPI similar in outpatients and inpatients. Increasing RPI with age in MR inpatients.
Greeley et al., 1976, USA	Blind Partially sighted & Totally blind	120	11-23	Modified Personal Hygiene Performance Index of Martens & Meskin (PHP-M) RPI	PHP-M scores improved with age in the partially sighted children. Oral hygiene was worst in the totally blind.
Ormer, 1976, USA	DS Unaffected siblings	212 124	5-20		Prevalence and severity of periodontal disease were greatest in DS children.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Svatun & Gjermo, 1978, Norway	Instit mentally subnormal	328	5-45	PII, Calculus-Modified retention index, GI, Periodontal Treatment Need system (PTNS)	Oral hygiene and periodontal health were poor. Increasing age, epilepsy, DS and a high degree of mental deficiency seemed to influence periodontal health and increase the treatment need.
Anaise, 1979, Israel	Blind Sighted	434 460	14-17	Simplified OHI – S RPI	Poorer oral hygiene in the totally blind compared to the partially blind and the sighted. The prevalence of periodontal disease was higher in blind compared to the sighted.
Mehrotra et al., 1982, India	Mentally and physically handicapped	127	8-55	RPI	Severity of periodontal disease was greater in the MR (RPI-2.64); compared to physically handicapped (RPI-1.26). The severity of periodontal disease showed an increasing trend with age.
Naoh, 1982, UK	Mentally and physically handicapped	98	5, 15 yr-olds	James (Oral cleanliness) index, (Gingivitis: Partial recording-labial anterior tissues)	Oral hygiene was poorer than in normal children.
Palin-Palokas et al., 1982, Finland	MR children Healthy	58 58	9-10	Visible Plaque Index (VPI), Gingival Bleeding Index (GBI)	Poorer oral hygiene in MR children than in healthy children. No difference in gingival status between the retarded and healthy. The mildly or moderately retarded had the poorest gingival health.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Forsberg et al., 1985, Sweden	Instit & non-instit severe MR and DS	100	3-17		Gingivitis was higher in MR children, and those with DS had extensive gingivitis.
Girgis, 1985, Canada	Severe mental, physical and other conditions	1094	5-45	Periodontal conditions: (0=normal, 1=gingivitis, 2=advanced periodontal disease, 3=gingival enlargement	Prevalence of periodontal disease was high. Frequency and severity of the disease increased with age.
Maclaurin et al., 1985b, UK	Different disability conditions Normal	3218 1344	2-19 4-16	James (Dental cleanliness) index Periodontal disease: Unspecified index	Poorer oral hygiene and greater prevalence of periodontal disease than in normal children. Children with MR had poorest levels of oral hygiene and greatest need for periodontal treatment.
Maclaurin et al., 1985c, UK	DS & other mentally handicapping conditions Normal	1720 1344	3-19 4-16	James (Oral hygiene) index, PI	Poorer oral hygiene and greater prevalence of periodontal disease in DS children than in normal children.
Vigild, 1985a, Denmark	Instit and non-instit MR with and without DS	329	6-19	Silness & Löe PI, Löe & Silness GI	Oral hygiene and periodontal health were poor. Children with DS had more severe gingivitis than other groups.
Barnett et al., 1986, USA	DS patients MR	30 30	< 15- ≥ 35 (mean = 27.4) (mean = 28.9)	PI	High prevalence of periodontitis found in patients with DS. Bone loss was found in 60% of sites in the DS patients, compared with 9.3% sites in controls.
Holland & O'Mullane, 1986, Ireland	Instit handicapped	194	3-50	Community Periodontal Index for Treatment Needs (CPITN)	Removal of sub-and supragingival calculus was the most common periodontal treatment need.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Jones & Blinkhorn, 1986, UK	MR children	340	5, 12, 15 yr-olds	Lennon & Davies, 1975 partial recording system	Levels of plaque and gingivitis were high. The handicapped had considerably more plaque and gingivitis than normal children.
Lizaire et al., 1986; Canada	Different disability conditions	1046	4-26	Simplified OHI Modified Russell Index	Overall OHI mean score was higher among 13 to 14 yr-old children with handicapping conditions than in those without handicapping conditions.
Mann et al., 1986; Israel	Instit physically handicapped	43	3-22	Quigley & Hein OHI	OHI was 3.62. The oral hygiene of boys was worse than for girls.
Pieper et al., 1986; Germany	Mentally subnormal	199	17-64	Quigley & Hein OHI, Sulcus Bleeding Index (SBI)	Oral hygiene was poor prevalence of periodontal disease was high.
Shaw et al., 1986, UK	Different types of handicapping conditions Normal	3562 1344	5-15	James (Oral hygiene Index) Periodontal treatment need: a) oral hygiene instruction only; b) prophylaxis & oral hygiene instruction c) complex treatment	Poorer oral hygiene and greater periodontal disease than in normal children. MR children had poorest oral hygiene and the greatest periodontal treatment needs.
Nunn & Murray, 1987, UK	Different types of handicap	1730	2-19	Oral hygiene index (OHI-S), CPITN	Oral hygiene and gingival conditions were poor in the handicapped children.
Maina & Lesan, 1988, Kenya	Mentally handicapped children	43	Not specified	OHI, GI	88.5% of the sites showed signs of gingivitis and 100% of these sites had dental plaque.
Thornton et al., 1989, USA	MR residents in a large institution, a small regional facility, and community group homes	62	18-45	OHI, The Extent and Severity Periodontal Index (ESI)	Plaque scores and periodontal disease levels were high in all groups. The group-home residents had significantly lower plaque scores than the other groups.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Costello, 1990, Ireland	Mentally & physically handicapped children and adults	155	14-55	CPITN	Moderate pocketing accounted for the bulk of the periodontal disease.
Nielsen, 1990b, Denmark	CP children	105	14 - 15 yr-olds	PI, GI	Plaque and gingivitis indices were significantly higher than those of the control group. Children with the mildest mental and motor handicap had lower plaque and gingivitis indices than the severely handicapped.
Francis et al., 1991, UK	Slightly, moderately and severely impaired young handicapped adults	195	25-34	James Dental cleanliness index, WHO, Periodontal assessment	More than half of the moderately and severely impaired had poor oral hygiene. 16% of the moderately impaired and 12% of the severely impaired had destructive periodontitis.
Gugushe, 1991, South Africa	Instit handicapped high school pupils: Physical, visual & Aural	267	14-23 (mean = 18.0)		The physically disabled had the highest proportion of bleeding, calculus accumulation and shallow pocketing.
Pope & Curzon, 1991, UK	CP children Control: Normal	150 191	Mean = 10.3 Mean = 10.4		Oral hygiene and gingival health were poor in the CP children.
Stabholz et al., 1991a, Israel	Instit DS children Control group I: healthy children Control group II: non-DS, MR	32 30 19	8-13	CPITN	Children with MR had higher periodontal treatment needs than healthy or DS children.
Vignesha et al., 1991, Singapore	Different disability conditions	322	6-18	Soft deposits (+/-) Calculus (+/-) Gingivitis (simple/intense)	The majority had soft deposits. More than half had calculus accumulation, which increased with age. Almost all had simple gingivitis and most had intense gingivitis.
Vyas & Damle, 1991, India	Different disability conditions Normal	260 206	11-14		Prevalence of periodontal disease was high in handicapped (95 to 100%) and low in normal children (54.4%).

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
El-Shennawy et al., 1993, Kuwait	DS children Normal	60 60	9-16 8-15	Silness & Loe PI & Silness GI	Oral hygiene was poor and prevalence of severe periodontal disease higher than in controls.
Nunn et al., 1993, UK	Physically handicapped children	129	3-17 (mean = 10.7)	CPITN	The majority (10 - 14 yr-olds) had healthy sextants but high calculus. The older children had gingivitis and much calculus. There were no pockets.
Ohito et al., 1993, Kenya	Different disability conditions	449	5-15		Plaque was present in all sites examined. Gingivitis was found in 37% of the children. Gingival condition was poor and gingivitis increased with age.
Bhavsar & Damle, 1995, India	Different handicapping conditions	593	12-14	CPITN	Gingival health and periodontal status was poor. Bleeding and calculus components were higher than the healthy components in all groups, and almost all the children required treatment.
Gizani et al., 1997, Belgium	Mild, moderate to severe mental retardation; Learning impairment	626	12 yr-olds	James Index	Evaluation of oral cleanliness showed poor oral hygiene in 31.8% of the children. No significant differences were found in oral cleanliness among types of handicapping conditions.
Shapira et al., 1998, Israel	MR children and adults [Four levels of MR]	387	3-41+	CPITN	Age-adjusted CPITN scores differed by behavioural group; the group with MR and severe physical handicap had the highest score.
Martens et al., 2000, Belgium	MR (mild, moderate, severe), physically handicapped, learning impaired	656	12 yr-olds	James Gingival health Index good, fair, or poor. James Index Oral cleanliness Index Calculus: Visual evaluation	Prevalence of gingival hypertrophy was highest in severely MR children. Oral hygiene was insufficient in all groups.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Mitsea et al., 2001, Greece	Children and adolescents with CP, MR and visual disorders	170	6-15	OHI - S	In children with MR, the oral hygiene status was moderate to low. Children with vision problems had better oral hygiene than the other groups.
López-Pérez et al., 2002, Mexico	DS subjects Control: Normal	32	15-39	Simplified OHI GI	The extent and severity of gingivitis and periodontal disease were greater in the DS group compared to control.
O' Donnell et al., 2002, Hong Kong	Mental and physical disabilities	748	4, 14, 25 – 35 yr-olds	Silness & Löe PI	Oral hygiene was poor. Oral hygiene deteriorated with increasing age.
Seymen et al., 2002, Turkey	DS children Control: Normal	48 48	3-15	Approximal Plaque Index (API) Sulcus Bleeding index (SBI)	Oral hygiene was poor. In the mixed and permanent dentitions, the API scores of the DS groups were higher than in controls. There were no significant differences in the SBI scores between groups, irrespective of dentition.
Chausshu et al., 2003, Israel	Insttit & non-insttit DS	23	11-22	Silness & Löe PI Löe & Silness GI Bleeding sites (%)	Oral hygiene and gingival health were better in the non-insttit than in the insttit group. Oral hygiene and gingival scores were lower in non-insttit individuals with DS.
McAlister & Bradley, 2003, Ireland	Different disability conditions	704	3-17	CPITN	Only 8.6% of 12 yr -olds and 4.7% of 15 yr-olds had healthy gingiva. The CPITN scores were higher in the 12 yr-olds than the normal. The 12 yr-olds with moderate learning disabilities had higher CPITN scores than the other groups.

Appendix 3. Summary of studies on malocclusions and traumatic injuries among the disabled.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Koster, 1956	Physical (CP children)				Athetoid children showed the highest prevalence of malocclusion (90%). The most common form of malocclusion was Class II, Division I, with anterior openbite.
Lyons, 1960	Physical (CP, poliomyelitis)	97	12-17		Prevalence of malocclusion was 77% in CP children, and 56% in children with poliomyelitis.
Tannenbaum & Miller, 1960	Insttit MR	38	12-22		The mental handicap group had a higher prevalence of crowding and increased overbites and overjets than the emotionally disturbed control group.
Brown & Cunningham, 1961	Insttit DS	80	1-39	Angle's Classification	39% had posterior crossbites; 49% had Class III malocclusions; 15% had anterior open bites; and 52% had a tongue-thrust habit.
Album et al., 1964	CP	47	7-10		Higher prevalence of malocclusion in CP than in normal children.
Magnusson, 1964	CP	76	3-15		The prevalence of malocclusion was within the normal limits.
Cohen & Winer, 1965	Insttit DS and non-DS	226	3-30		Increased prevalence of Class III type malocclusions in DS individuals.
Kisling, 1966	DS	71	19-25	Angle's Classification	69% had class III malocclusion.
Rosenbaum, 1966	CP	124	6-12		Prevalence of malocclusion was not different from normal.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Fishman et al., 1967, USA	CP Non-CP siblings	203 335	4-18	Draker's handicapping labio-lingual deviation index	CP children after 6 years of age more often had handicapping malocclusion than their siblings.
Gullikson, 1969, USA	MR	201	3-14	Angle's Classification	67% had malocclusion with greater predominance of Class III malocclusions (12%) than in the normal population.
Miller & Taylor, 1970, USA	Orthopedically handicapped children	411	Not specified	Angle's Classification	Prevalence of malocclusion was within normal limits. The arthritis, Legg-Perthes and miscellaneous groups had a higher prevalence of Class II and III occlusions than normal children did.
Rosenstein et al., 1971, USA	Non-institut MR attending occupational day centers (DS, mentally deficient)	72	17-43 (mean = 25.1)	Angle's Classification	Higher prevalence of malocclusion (98.6%), than the general population.
Swallow, 1972, Israel	MR, physical & medical	929	13-16	Angle's classification	No significant difference between the mentally handicapped and normal children.
Gullikson, 1973, USA	DS children and non-DS, MR	202	3-10	Angle's Classification, Cross bites, anterior open bite	Increased prevalence of Class III malocclusions (50%) and crossbites (14%) in the DS group than in the non-DS group.
Jensen et al., 1973, USA	DS	129	3-41	Angle's Classification	59% had class III malocclusion.
Foster et al., 1974, USA	CP	33	3-28		Severe CP associated with increased prevalence of malocclusion.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Svatun & Helöe, 1975, Norway	Instit mentally subnormal	353	5-45	Angle's Classification	Class III malocclusion was more prevalent than in normal population (43% and 16%).
Greeley et al., 1976, USA	Blind students Partially sighted & Totally Blind	120	11-23	Angle's Classification Ellis' Classification of fractures	55% exhibited bilateral Class I, while 21% had Class II and 5% had Class III. The blind population did not differ from general population in malocclusion. 27.4% sustained a fracture to their permanent anterior teeth.
Girgis, 1985, Canada	Different disability conditions	1094	5-45	Angle's Classification	81.1% showed deviation from normal. 25% had crossbites. Posterior crossbite and underdeveloped maxilla were in 58% of individuals with DS. High prevalence of severe malocclusion, large overjets, lingually inclined mandibular incisors, and anterior openbites were observed in quadriplegic and paraplegic patients.
Vigild, 1985b, Denmark	MR & DS	218	13-19	Björk et al.,	Mandibular overjet, mesial molar occlusion, crossbite and frontal openbite were more common in DS children compared to MR and normal children.
Lizaire et al., 1986; Canada	Different disability conditions	1046	4-26	Anteroposterior molar relationship	Higher prevalence of untreated dentofacial anomalies of the types affecting space and occlusion than in children without handicap.
Nunn & Murray, 1987, UK	Different disability conditions	1730	2-19	WHO, 1977, Malocclusions & Traumatic injuries	Prevalence of malocclusion higher than in normal children. Half of the mildly mentally handicapped and two-thirds of the severely mentally handicapped children had malocclusion. A sizeable proportion (28.8%) of children had traumatised anterior teeth.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Oreland et al., 1987, Sweden	Mentally and physically handicapped children	115	3-17	Occlusion, space conditions	Severely MR children had higher and more severe malocclusions than physically handicapped and healthy ones.
Costello, 1990, Ireland	Mentally and physically handicapped children	171	4-16	Ellis' Classification of fractures	29% of the children had trauma to incisors, and prevalence was greater for children in residential care than for children in day care.
Pope & Curzon, 1991, UK	CP children Normal	150 191	Mean = 10.3 Mean = 10.4	Overjet, crowding	Significantly greater overjet (and less crowding) in the handicapped than in normal children.
Vignesha et al., 1991, Singapore	Different disability conditions	322	6-18	Severe malocclusion	Severe malocclusion was present in 29% of the subjects. The intellectually disabled (DS) had more malocclusion than those with visual or hearing impairments.
O' Donnell, 1992, HongKong	Visually imapired	88	-	-	There were significantly more fractures of anterior teeth in the totally blind than in the partially blind.
Ohito et al., 1992, Kenya	Different disability conditions Normal	449 2342	5-15	Not specified	Prevalence of traumatic injuries was higher in handicapped children (18%) than in normal children (11%). Boys had higher prevalence (14%) than girls (11%).
Ackerman & Wiltshire, 1994, South Africa	Mentally and physically handicapped	381	-	Occlusal Index (O.I) of Summers	74.5% required treatment, 10.5% had good occlusions and 15% had slight malocclusions. Schools with CP and mentally disabled children had a slightly higher O.I.

Author(s), Year, Country	Type of Disability	N	Age (Years)	Indexes	Main Findings
Denloye, 1996, Nigeria, Africa	Mentally handicapped schoolchildren	205	6-9	Not specified	High prevalence of 20% and a higher proportion of girls than boys were found to have fractured anterior teeth. The 13 - 15- yr age group had the highest prevalence (20.7%). Tooth fractures more common in the upper jaw.
Franklin et al., 1996, UK	CP children Normal	34 34	6-16	Overjet, overbite, anterior openbite, posterior crossbite, incisor irregularity, incisor relationship, arch width & arch circumference.	Malocclusion more common in CP children. Increased overjet and overbite compared to control. Tendency toward Class II malocclusion and likelihood of incompetent lips.
Mitsea et al., 2001, Greece	Children and adolescents with CP, MR and visual disorders	170	6-15	Occlusion	More than half of the subjects had malocclusion, 59% in children with cerebral palsy, 57% in MR children but only 39% among the children with vision problems.

Appendix 4.

Ministry of Health Oral Health Survey of Disabled Schoolchildren in Kuwait

Examiner	
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Date of Examination						
	Day	Month	Year			

Name: _____

Civil ID Number												
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Sex	
1 = Male	
2 = Female	

Age		
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Nationality	
1 = Kuwaity	
2 = Non-Kuwaity	

Date of Birth					
	Day	Month	Year		

School		
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Class		
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Dental Caries Assessment:

		RIGHT								LEFT								
		18	17	16	E/5	D/4	C/3	B/2	A/1	1/A	2/B	3/C	4/D	5/E	26	27	28	
PRIMARY / PERMANENT																		
	D																	D
	O																	O
	M																	M
	B																	B
UPPER	L																	L
PRIMARY / PERMANENT		48	47	46	E/5	D/4	C/3	B/2	A/1	1/A	2/B	3/C	4/D	5/E	36	37	38	
	D																	D
	O																	O
	M																	M
	B																	B
LOWER	L																	L

CPI	16	11	26
[0-4, X]			
	46	31	36

Malocclusion

[0 - 2]

T/brushing Frequency

[0 - 3]

Dean's Index

[0 - 5]

Help T/brushing

[0 - 2]

Oral Hygiene Score

[0 - 2]

Ministry of Health
Preventive Oral Health Programme for Disabled School Children in Kuwait
Toothbrushing Programme

Examiner

Date

Name: _____

Civil ID No

Sex 1=Male
2=Female

Age

Nationality 1=Kuwaiti
2=Non-Kuwaiti

Plaque/Gingivitis Exam Form

Base-Line

Upper Teeth

Tooth #	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Plaque	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
Gingivitis	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>

Lower Teeth

Tooth #	47	46	45	44	43	42	41	31	32	33	34	35	36	37
Plaque	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
Gingivitis	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>

Final

Upper Teeth

Tooth #	17	16	15	14	13	12	11	21	22	23	24	25	26	27
Plaque	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
Gingivitis	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>

Lower Teeth

Tooth #	47	46	45	44	43	42	41	31	32	33	34	35	36	37
Plaque	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>
Gingivitis	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>	<div></div>